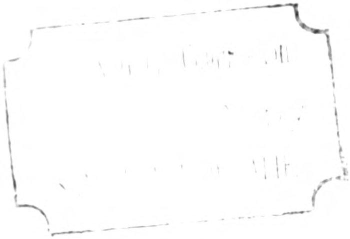

CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

VOLUME 23 SACRAMENTO, JANUARY, 1937 No. 1

TABLE OF CONTENTS

SIXTEENTH ANNUAL CONFERENCE

WESTERN ASSOCIATION OF STATE GAME AND FISH COMMISSIONERS

July 22 and 23, 1936, San Francisco, California

ADDRESS

By ELLIOTT S. BARKER, President, Western Association of State Game and Fish Commissioners; and State Game Warden, New Mexico.

Delegates to the sixteenth annual conference of the Western Association of State Game and Fish Commissioners, ladies and gentlemen, and friends: It is a great pleasure to see so many familiar faces here today, to meet in conference with you and to welcome many new officials to take part in our deliberations.

It is my understanding that one of the chief prerogatives of the president of an organization is the privilege of making the first speech following the opening ceremonies. As an advocate of states' rights I do not intend to surrender any prerogatives.

I have a bright little daughter fourteen years of age who came to me the other day and said:

"Daddy, you must be careful of your health, drive your car carefully and avoid accidents."

"Why so?" I asked.

"Because," she replied, "if you were to die that would be the end of our family tree."

"Oh, no," I said, "You're wrong. I have brothers and a son to perpetuate the name. I'm not that important."

"No, I'm not wrong," she said, "for don't you know that no tree, not even a family tree can live without its sap?"

When the delegates to the fifteenth annual conference of the Western Association insisted against my will and against my best judgment in reelecting me as president of our great Association, I thought it was a mistake. I have not changed my mind about it, and you all probably now agree that I was right.

They may, however, have felt that the requirements of our Association were the same as the requirements for perpetuation of a family tree. Right or wrong, your humble servant has been duly appreciative of the honor bestowed upon him and I hope not unmindful of the great responsibilities of directing the affairs of our Association. I have endeavored, to the best of my limited ability, to serve you and to promote wildlife programs and policies for the best interests of our great western empire.

Ten and a half months have passed since the Western Association of State Game and Fish Commissioners met in that memorable con-

vention at Santa Fe, New Mexico. Short as the lapse of time seems, much of importance has transpired since that meeting, some of which, at least, we hope will result in benefiting wildlife in our great western states. We hope that some events have served to bring about closer cooperation and a better understanding with other agencies and organizations concerned with the welfare of wildlife. We feel that game, fish and conservation officials of the eastern states understand some of our problems better than they did a year ago. We believe that some progress is being made in bringing land users and wildlife interests closer together.

We have a rather full and I hope worth-while program ahead of us, which will be far more interesting and constructive than anything I can say to you, and I shall, therefore, take up very little of your valuable time. However, I believe a brief review of the past year's activities will serve to some extent as a basis for our deliberations and actions at this our sixteenth annual conference.

When we met at Santa Fe last year, practically all western officials and sportsmen were in a turmoil of dissatisfaction over the then recently announced migratory bird seasons. The dissatisfaction was not in giving the birds a chance or giving them the protection they need. We were in accord on that even to the extent of a closed season if deemed necessary. We did oppose the back-handed, discriminatory, or thoughtless closing of seasons in certain sections of the country by establishing the shooting dates either before the birds had arrived or after they had left.

Proceeding to the International Association of State Game, Fish and Conservation Commissioners' conference at Tulsa, Oklahoma, on September 12th and 13th, I found virtually the same sentiment existing there. At both conferences appropriate resolutions were passed urging closer cooperation by the U. S. Biological Survey with state game officials in the establishment of seasons.

While the 1936 migratory bird seasons have not been announced, I have reason to believe that the new Chief of the Biological Survey, Honorable Ira N. Gabrielson, in whom I have great confidence, is making a worthy effort to cooperate and consult with state game authorities in establishment of migratory bird seasons that will be fair to birds and sportsmen alike. There can be no doubt that recent excessive losses of young ducks on much of the breeding area due to the drouth will seriously affect the supply and that it will add to the growing public sentiment for a closed season is also evident.

Another subject that occupied much time at the fifteenth annual conference was making provision for wildlife on grazing districts established on the public domain under the Taylor Grazing Act. The action of our Association was to reaffirm the stand taken at our special meeting in Denver on February 14, 1935. The salient features of our stand have been:

1. Urging recognition and acceptance by Department of Interior officials and stockmen alike of the principle that wildlife is entitled to share in the use of all of the public domain lands.

2. That such reasonable joint or common use with livestock over large areas will produce far more game than restriction of game

to established game ranges even if use of such areas were devoted exclusively to wildlife.

3. That in addition to joint use, limited areas of hereditary game ranges of highest value for wildlife should be so designated and devoted primarily to wildlife use, subject, however, to administration by state game officials.

4. That the remainder of the public domain should be put under administration.

5. That the Secretary of the Interior should provide for an appropriate cooperative setup with official state agencies charged with wildlife administration. (These provisions are all included in the rules approved for New Mexico.)

Here again I found the International Association pretty much in accord with the principles of the stand taken by the Western Association. The eastern, southern and midwestern states' officials were greatly interested in this subject and one whole afternoon session was devoted to a discussion of it.

At the fifteenth conference we reiterated our opposition to Regulation G-20A of the Forest Service, and reaffirmed the stand taken at our fourteenth conference at Portland, Oregon, and the special conference in Denver on February 14, 1935. While there seems to be a considerable difference of opinion among Forest Service officials as to the propriety and authority for this regulation, I regret that there seems to be no inclination on the part of the Forester or Secretary of Agriculture to withdraw it. On the other hand I see no reason for us to change our attitude.

A resolution urging greater cooperation and coordination by state and federal officials responsible for public works projects to avoid injury to wildlife was passed at our last conference, and events of the year have proven the necessity for eternal vigilance. Still others urging the U. S. Bureau of Fisheries to continue studies and experiments with fish foods and treatment of fish diseases were passed.

From our fifteenth conference, let us pass on to the International Association conference at Tulsa, Oklahoma, which I, with several other western officials, attended. Suffice it to say that in addition to the actions already referred to, I feel the problems of the west, the power of the Western Association and the importance of the western states as the vital factor in future production of big game, seemed to be recognized to a greater extent than I have observed in many eastern conferences.

Coming as a complete surprise, and I think without justification, your president was honored by being elected president of the International Association of Game, Fish and Conservation Commissioners, also. I find the position hard to fill creditably without neglecting the affairs of the Western Association, which during my tenure of office, I have endeavored not to do.

You are all so familiar with the North American Wildlife Conference held in Washington, D. C., February 3 to 7, 1936, that a review of our activities at that meeting would be superfluous at this time. However, I may state that it was most gratifying that practically all of the eleven western states were well represented. We held several special sessions and I believe you will agree did some effective work.

To say that the west and its problems were given greater recognition at the General Wildlife Conference than at any previous eastern wildlife conference is putting it very mildly indeed.

What will come of the General Wildlife Federation remains yet to be seen. At this conference we shall undoubtedly hear some encouraging words of the progress being made from the acting president, J. N. Darling, who some time ago assured me he would attend our conference.

One of the many important actions taken by our Association while at the wildlife conference was to direct a letter to the Chief Forester, calling his attention to the necessity for careful consideration of present and future wildlife needs in establishing a ten-year grazing permit policy for national forests, and in reduction of permits for greater distribution of grazing privileges, which at that time was under consideration. This letter had a beneficial effect but whether adequate or not is for you to judge. The ten-year permit policy established, with which you are, no doubt, familiar, limits reduction of permits for greater distribution to twenty per cent. and the maximum reduction for all purposes, prior to the end of 1940, is limited to thirty per cent. Thereafter, reductions may be made as circumstances warrant. If reduction for protection includes the needs for wildlife, as I have been assured that it does, then the policy seems reasonable and fair; otherwise, quite the reverse would be the case.

The most recent activity of our Association through correspondence has been opposition to the first and second sections of the Kleberg Bill, which we believe contains some dangerous wording. No definite attitude has been expressed as to our stand on the main objectives of the bill which I personally believe are worthy, but that should be determined by this conference. We do not desire to inject any nonessential nor extraneous matter into this bill, but certainly we do not want the Department of Agriculture to inject intentionally or otherwise a legal leaning post for encroachment upon states' rights in the administration and regulation of non-migratory wildlife.

Among the important actions during the past year are included three outstanding happenings which may have a far-reaching effect upon the future wildlife policies in the western states.

First, the tentative formation of the General Wildlife Federation which has possibilities for bringing land users, sportsmen, official wildlife agencies and the public into closer harmony.

Second, the appointment of Dr. Ira N. Gabrielson as Chief of the U. S. Bureau of Biological Survey, whose qualifications from the standpoint of education, experience and familiarity with western conditions eminently fit him for the place.

Third, the setting up of a Game Management Division in the U. S. Forest Service and the selection of Dr. H. L. Shants, formerly head of the University of Arizona, as chief. This has great possibilities for good in restoration of wildlife habitat and properly correlating the uses of national forest lands. However, the need for another technical wildlife setup to parallel the work of the Biological Survey, or to supplement it is not apparent.

I could continue discussion of the activities of our Association and related happenings, but I am taking up too much of your valuable time and we need to be getting on with our program. Permit me to say in

closing that it is my earnest hope in our deliberations at this conference that we will stand strongly together as our Association has on every important question for fifteen years. Let us take and recommend constructive action where action is needed to further and protect wildlife interests. In short, let us make this conference worth-while and outstanding among those of the past fifteen years.

I thank you.

It is with great regret I have to announce that our old friend and one of the original members, Mr. Roland G. Parvin of Colorado, can not be with us today. He was scheduled to give a little talk on the history of the Western Association, but some unfortunate events, one of which was the sudden death of his chief assistant only a few days ago, have prevented Mr. Parvin from being with us today. I have a wire with me I would like to read:

> "Greetings to the Association and more power to you. I so deeply regret not being with you as you open your session this morning and I am wishing you a most successful and pleasurable meeting. Say 'hello' to everybody for me. Keep your noses dry, head cool, feet warm and everything will be jake." R. G. Parvin.

Mr. Parvin has been kind enough to send along a paper entitled "History of the Western Association," which I have asked Mr. Newell B. Cook of Utah to read at this time.

HISTORY OF THE WESTERN ASSOCIATION

By R. G. PARVIN, Vice-President, Western Association of State Game and Fish Commissioners; and Game and Fish Commissioner, Colorado

The office of State Game Commissioner is a great vantage point from which to watch a nation set its house in order, and to assist somewhat in that endeavor if one be so inclined.

For eighteen years, from my office in the Colorado State Capitol, I have watched the march of events with interest and concern. I have seen this great nation of ours slowly awaken from its spendthrift dream of inexhaustible wealth to take alarmed and sober accounting of itself and its possessions, not only in relation to the present, but to the future.

Beginning with the Indians, whose tribal laws controlled the use of game that there might be a continuing food supply, down to the present time when planning commissions talk earnestly of soil conservation, land use, game management, etc., *small* groups of people have always preached conservation and unselfish use of natural resources. But only in the last twenty or thirty years has the "man in the street," so to speak, given any thought at all to the fact—to quote a recent and much-used phrase—that "the frontiers are gone." Almost unbelievingly this "man in the street" has discovered that the virgin country he thinks of as teeming with forests, land, water, metals, wildlife, to be had almost for the asking, is a thing of the past. If impatient with conditions, he must change them where he stands. He can not move on to new fields and start over. Horace Greeley would not now advise the young man to "*Go* west." He would be compelled to say, "This is your

West, young man, what are you going to do with it? Shall it stand, as its mountains stand, the symbol of beauty, strength and freedom, or will you let indifference, greed and ignorance have their way to exploit, waste and despoil it?"

The Western Association of State Game and Fish Commissioners is one of the answers to that question. It came into being at the time the national conscience began to sting with remorse at its neglect of wildlife, the havoc wrought by hunter and trapper, and the barren state of public waters. It is doubtful if anyone at the first meeting even dreamed of the strong, closely welded organization we now have; this union of western states standing together through their game and fish commissioners pledged to preserve for themselves and control for themselves the natural resources within their boundaries.

The first proposal of an association of western states was made by the Game and Fish Commissioner of Utah in 1918, just after the Armistice was signed. An epidemic of influenza caused it to be postponed. A second meeting was arranged for February, 1920, and again influenza caused a cancellation of the date. It was left for Dave Madsen, succeeding the former Utah commissioner, to finally gather around his camp fire at Salt Lake City in January, 1922, the states of Arizona, Colorado, Montana, New Mexico, Utah, Oregon and Wyoming. California, Idaho, Nevada, and Washington, the remaining states eligible for membership, were not present. Nevada has never joined the Association. An amendment to the by-laws at the second meeting provided that honorary members might be admitted to the association and allowed to participate in its deliberations, but without the right to vote or participate in any official business.

The objects of the Association as stated in the by-laws are:

> "To promote harmony and unity among its members and members of like associations throughout the country for the purpose of exercising a combined and powerful influence in securing enactment of laws, and amendments to present laws, favoring the propagation of game and fish, and to further provide for just, reasonable and uniform laws and regulations for the protection of same."

The Association unanimously agreed at this meeting that steps should be taken to prevent the extermination of bears; that beaver should be protected in all the western states insofar as could be done without interfering with agricultural, industrial or livestock interests. A uniform price of three dollars for non-resident fishing licenses was agreed on in the states represented; legislation was favored making it a misdemeanor to possess game taken in an adjoining state unless the possessor could show legal possession. The Association unanimously disapproved centralization of control in the federal government of game, birds, animals and fish in the confines of any state, and in that connection disapproved a bill providing for a federal license to hunt migratory birds. This disapproval was based not so much on the license feature, but on the extent of the authority conferred upon the U. S. Department of Agriculture. It was due largely to the influence of the Western Association that this pernicious legislation was finally defeated.

The Association has not swerved from the course it first charted. It has stood firmly against encroachment by the federal government on the rights of the states to ownership and control of wildlife within

their borders, but it has done more than that. It has sought to build up among its members a broader outlook, a deeper sense of responsibility in the administration of state departments, a better knowledge of general conditions and the necessity of cooperation with the different agencies concerned with wildlife conservation. There has been free and frank discussion of all phases of state problems, and being in complete accord with each other on fundamental principles, these discussions have always resulted in bringing the states closer together and strengthening their common purpose and their common knowledge.

The Association has a sympathetic nervous system, and seems to become immediately conscious of anything that affects the general welfare. Its influence is quietly but steadily directed wherever it is needed, and I think we are not flattering ourselves in feeling that it is a factor to be reckoned with. As in the beginning, its policy has always been to work with the federal government in all legitimate undertakings to promote wildlife interests, but staunchly to oppose federal ownership and control. No doubt one of the greatest achievements of the Association has been in creating a better understanding between different sections of the country, and therefore greater tolerance. When intelligent, thinking men put their feet under the table, look each other in the eyes and frankly discuss affairs, difficulties are usually reduced to the lowest common denominator. This fact has been proved many times in this Association. Fortunately, from our first president, Dave Madsen (and a little later I will tell you what rating Dave had among the charter members) to the present go-getting Elliott Barker, we have had liberal minded, level headed, straight shooting, clear eyed men at the head. They have been actuated by a single purpose and have very seldom been tempted to deviate from that purpose. Consistency has been the watchword from the start, and consistency combined with honesty and unselfishness is hard to beat.

Our final business meeting in 1923 was held in Old Faithful Inn in Yellowstone Park, where we had gone as guests of Montana. This meeting marked the beginning of our intercourse with national agencies and associations, and ever since then, these agencies and associations have been as well represented at our meetings as have the member states themselves, and have contributed in large part to the growth of interest and activity. Representatives from our Association have also participated in the meetings of all major organizations and have kept in close touch with everything in the world of conservation. A lot of cross purposes were adjusted at a concurrent meeting of the American Fisheries Society, the International Association of State Game Commissioners, and the Western Association in Denver in 1925, at which the National Association of Audubon Societies, the Izaak Walton League, the U. S. Forest Service, U. S. Bureau of Biological Survey, and other organizations were well represented. It was well that our Colorado climate was in a pleasant mood and served the cool mountain air the crowd expected, otherwise the heat thrown off by some of the arguments that went on might have started a conflagration.

Each member state at one time or another has extended its hospitality to the Association, and every occasion has been a bright spot in the year's work. I, for one, have always returned to Colorado from our meetings with aroused enthusiasm, with new ideas and

with a broader concept of the vast field in which we are actually pioneers. Wildlife conservation is still in its infancy—a big, clumsy infant without much shape, but with potential energies that will develop into a great instrument for good under proper guidance. Regional associations have their part to play in bringing about a well-balanced, carefully planned national program, as well as in looking out for their regional interests. I believe the future progress of the Western Association depends upon its continued open mindedness and unselfish devotion to the American ideal of justice to all and malice toward none, which has earned it the respect of all agencies it has so far contacted.

The credit for the successful organization of this Association rightfully belongs to Dave Madsen, that progressive, forward looking gentleman who at present devotes his genius to federal affairs, but who keeps one eye single to the interests of Utah and the western states. What the Association thought of him (and still thinks) is well expressed in the following resolution adopted by the convention in San Francisco in 1922:

> "WHEREAS, Under the leadership of Commissioner Madsen, and as a result of his far-seeing judgment that is second only to the revelations of the great founder of Utah, Brigham Young, this Association bids fair to promulgate and adopt conservation measures that will make the regulations and efforts of our time-worn and world-wise Eastern conservationists look like a nickel's worth of radium; and
>
> "WHEREAS, Our worthy retiring president has earned his much merited spurs as a pathfinder through his ability to steam in a fog on an unknown and uncharted sea; therefore be it
>
> "*Resolved*, That Mr. David H. Madsen be extended the appreciation and gratitude of all humans interested in conservation of the natural resources of the West," etc.

"Cap" Burghduff was one of the fire-eatingest members of our early days. Age tames us all, but "Cap" can still stir up quite a bit of smoke if he gets "riled." There is no use reminiscing, but I wish you could all have heard Bruce Nowlin when he got relaxed and started on some of his old Wyoming cowboy songs. It has been a great old crowd, and it is still great, and I am proud and happy to be associated with men of the type always gathered in these conventions, simple, sincere and honest, striving in their respective offices to do their part in helping to make of our Nation one of the greatest on earth.

As I dictate these words, I am well aware that I shall not speak them to you. Through the kindness of Mr. Barker they will be read by proxy, but I want you to know that it is through no fault of my own that I am not among you. Circumstances over which I have no control prevented my leaving Colorado, and it is the first meeting I have ever missed. I regret it more than I can say, but as one of the charter members, I want to say to you that you have a great Association, and one that is increasing in strength and usefulness with every passing year. It has a great work to do in the future, and there is no fear but that it will be done faithfully and well. More power to you!

If it is the pleasure of the members, I hope the meeting will be held in Denver in 1937. The State of Colorado extends its compliments, and a most cordial invitation to come to our Capital City next year. I thank you.

GAME AND FISH MANAGEMENT AS APPLIED IN CALIFORNIA

By HERBERT C. DAVIS, Executive Officer, California Division of Fish and Game

We have here for distribution to the members of this Association the latest copy of the "California Conservationist." This little magazine is a popular publication put out by the Department of Natural Resources under the leadership of our good director, George D. Nordenholdt, who is right now talking to Mr. Gabrielson asking for an extra month on the duck season. I haven't been able to get Mr. Nordenholdt to come up and say a few words to you.

This publication ties in with our program of game management. We feel that the fish and game resources of the State can not be administered by the State alone. It requires the combined cooperation of all of the sportsmen's groups and conservationists. Therefore, this popular magazine on fish and game matters has been established to acquaint the people with the need and the manner of conservation. In addition to that, you are all familiar with our publication, "CALIFORNIA FISH AND GAME," which, we believe, and have been told by others, is one of the outstanding publications in the United States on fish and game subjects. That magazine, since the introduction of the new one, is becoming even more a place to record accurate scientific data and research.

The reason that we stress that phase of our work in game management is because this program in California hinges around four points. I like to look at our picture here as one of taking a piece of paper and saying that here is our game management program, supported with four corners.

The first one is to know all that is to be known of the biological habits of every species we deal with, whether it be fish or game. We must know the life history, migrations, feeding habits and everything to be known about the bird or fish. That is Corner 1, and for that purpose there is maintained in California a very extensive research organization. Most of it is contained within the Division of Fish and Game, some borrowed from two of our educational institutions—the University of California and Stanford University.

The second corner on the top of the page is the facility for propagation—either natural or artificial. We have tried in this State to develop the most modern, scientific and economic methods of artificial propagation of both fish and game, realizing, however, that they are merely supplements to what Nature is doing. A portion of our time is spent in carrying on this artificial propagation. The balance of our time on this particular corner of our program is spent in attempting, in cooperation with the U. S. Forest Service and other land management agencies, to reestablish, rebuild and recreate the natural propagating areas and in that connection we use the game refuge as well as the rest of the fellows.

The third corner is the one that is the latest innovation in California—the inventory of fish and game. We may know all there is to

know about the life history of some bird or beast and carry on with good knowledge what we may expect from that particular species. We may know all there is to know about propagation. But, we can not manage our fish and game unless we have something in the way of an inventory—we view fish and game management in California as a strictly merchandising business. The field and stream is the merchant's shelf; the fish in the stream and the game in the field are the goods on the shelf. The sportsman is the customer and his kill is the sale. The customary, old method of taking inventory was to count what was left at the end of the year. You know what you bought and had to start with, and you knew what was sold. You don't care what is left on the shelf.

We put into effect in this State a system to record the fish and game kill. When you go to purchase a fishing or hunting license in the State of California, you make out an application blank, giving your name, age and residence. In addition there is a place to tabulate how many pheasants you killed last year and where you killed them; how many doves or ducks; how many trout were taken; and the counties from which they came. Naturally this information includes the home county of the hunter, and the amount of traveling done in pursuit of game can be estimated. This statistical information is tabulated at the California State Fisheries Laboratory at Terminal Island, along with other statistics pertaining to the commercial fish catch and the kill of deer. The data are handled by punch card machines that furnish almost any kind of information—totals or special reports. I am only sorry Terminal Island is so far away that I can not take you there to show you the laboratory. Mr. W. L. Scofield, the director of the laboratory, and Miss Geraldine Conner, fisheries statistician, are both here and can give you any details you may want.

As a result of this, we believe we are now approaching the fundamentals of game management in being able to apply these merchandising methods. If we know where the game is today, by whom taken and in what quantities, we then are in a position to do something about replacement and protection. So, therefore, the third corner of our paper is made up of a program of inventory.

The fourth corner is one we are just starting on and it will be an innovation in game management so far as California is concerned. We are preparing to make a complete and comprehensive survey of every square inch of land in the State with reference to game and fish—a job that will probably take ten or fifteen years to complete, and if we had to pay for it in the ordinary methods it would cost several million dollars. We have gotten around that expense proposition, however, by an innovation in our patrol methods which provides for junior game wardens. These men will be trained to make these surveys at the same time they are patrolling their areas, which will be easy because we have a unique principle of law enforcement in California. We try to protect the game rather than apprehend the violator, and we believe the presence of our wardens in the community is more important than apprehension and punishment. We want to stop the fellow before he has taken over the limit of 25 trout rather than catch him after he has taken 100 and is going home with them. Catching him before he violates the law in this case would save 75 trout for somebody else.

Getting back to the survey, I may say it will include a complete and accurate record of every inch of stream and every acre of lake in the State of California, with a fairly good estimate as to carrying capacity in terms of fish and what needs to be done to improve the streams. In view of the records we have on the amount of fish taken out of any particular stream, we will know what we can do to improve our planting methods to secure proper distribution. For the most part, our inventory will give detailed information, and that is no small job when you stop to consider there are 25,000 miles of fishable streams.

We are not going to stop only with the water, but will take in the field itself. Every square acre will be surveyed and plotted on a map of the State. We have already a map which shows after careful surveys, the deer range in California—the maximum amount of country where we can hope to have deer in this State. The balance is unsuitable for deer or is essentially valley and agricultural lands. If you can imagine a similar map made on a large scale, accurate to a square township, to provide us with information as to the exact area suitable for every distinct species of game, you gentlemen who are charged with game management can realize what a tremendous help that would be. The maps I have here will be on display for your closer inspection. All of this is a part of a definite game management program.

I might divert here for a second to call your attention to the fact that the reason we have game management programs in California and operate on a business-like basis is because we have such a large State. It is 1100 miles from the Oregon line to the Mexican border, and if you wander along the coast you must travel 1300 miles instead of 1100. It is about 300 miles wide. We have a terrible time trying to keep 6,000,000 people, the fish and the game, all in the same place at the same time.

I would say the people of California are not so forward looking, but they have been driven to it now by necessity. Fortunately our large population has given us a large revenue so it is possible for the State to maintain some 400 employees to carry out this conservation work. It would be interesting some time for someone other than myself to sit down and write a lengthy paper on the subject of game management in the State of California, setting forth in detail the statistical and other information we utilize in carrying out our program. Perhaps some day when I have the urge, I might write such a thing for "CALIFORNIA FISH AND GAME" in order that the other states might benefit from the knowledge we have gained. Suffice it today to merely give you a brief outline of what we believe to be as well rounded, as complete and as comprehensive a program as you can find any place in the country as far as application of game mangement is concerned.

We apply exactly the same principles to the management of our commercial fisheries off the coast of this State; the fishing industry is a tremendous one, amounting to something like $30,000,000 annually. For a number of years we have kept careful and complete records of the catches made by our commercial fishermen. I would like to give more details, but I can not do so in a fifteen minute talk. In closing I want to hark back to the inventory proposition to show how it works.

Believe it or not, the people of the State of California, during the 1934–35 season, legally killed about 500,000 rabbits. They killed about 800,000 ducks, over a million doves and more than a million quail. They

shot 50,000 pheasants in spite of the fact that the season is but six days long, had only been open for a couple of years and the pheasant is strictly an introduced bird in this State. We thought we were doing a big job when we planted thousands of birds a year, but Old Mother Nature must have been doing pretty well herself in propagating enough birds to permit such a large kill.

An analysis of this kill shows the necessity of applying merchandising methods to game management in California so that we can manage the game Nature put there rather than what we put there. It also impressed us, because we realize that our biggest problem is to rehabilitate, recreate and aid Nature rather than try to go into artificial propagation because we couldn't raise that many quail artificially unless sportsmen were willing to pay $30 a year, which we could not ask of them.

We have maps that show the location and approximate number of every species of bird that has been planted in the State of California. If we study one of these maps, showing the plantings, we can check these planting areas against the statistical returns from the hunter. We can determine exactly how effective our planting was and whether or not it was safe to plant in areas where hunting is permitted or in closed areas where the only hunting is outside the refuges from the overflow of birds planted in the closed areas. We can find out whether the birds took hold.

We have maps for valley quail, Reeves pheasants, Chukor partridge, ring neck pheasants, and turkeys. We had no pheasants in California until we planted them, so those we have now are the result of our game management program. The Chukor is another introduced species, such as the pheasant, and we have not yet had an open season but hope to within five or six or seven years. Mr. Bade, how far do you want me to go?

BADE: About five years.

DAVIS: You are optimistic. This last map shows the areas in the State where the Fish and Game Commission operates a very comprehensive predatory animal control program. Our predatory animal control is a three-cornered one and consists of a council made up of a representative of the State Department of Agriculture, a representative of the U. S. Biological Survey and a representative of the State Fish and Game Commission. They sit down together to iron out the problems, and they have divided the State and all three agencies have their share of the work cut out for them. That map shows what we have attempted to undertake.

I am sorry we didn't bring over another map which is the patrol map showing a highly organized fish and game patrol which is under the jurisdiction of the commission but strictly under our control and one of our most highly organized bodies. The purpose of uniforming our men is that we believe the presence of a warden prevents violations. We have an under-cover squad to get the violators who get away from the uniformed men.

Before the conference is over, on our return from the trip to the Yountville Game Farm, we will take you for a ride on a portion of the fish and game naval patrol—California's miniature navy. We are the

only State that maintains a sizeable fleet and we would like you to see some of the boats.

All of these things combined constitute the fish and game management program of the State of California—life history research, propagation, inventory, surveys, publications and patrol. I submit it to you for what it is worth and what you may be able to to get from it for application to your own State. I would welcome from you suggestions as to how we might improve on a program that we think is pretty good but needs improvement, and as far as we have facilities to do so, we would like to carry out suggestions you might be able to make.

Discussion Led by George K. Aiken, Oregon

MADSEN: I would like to ask Mr. Davis how many deer were killed?

DAVIS: About 22,000.

AIKEN: Probably it is out of place for Oregon to discuss game management because the Legislature has never seen fit to give it to our State.

The people at Bend, sportsmen, hotel owners and all of the other kindred industries that profit directly from the presence of fish and game in the Bend area have an organization that represents each of the several branches. They meet once a week and the larger groups, the chamber of commerce, meet to check up the actual income from the people of Bend to check on what they get from hunting. The editor of the "Bulletin" told me that they ascertained the tangible income to the people of Bend was into the thousands of dollars. I was surprised since then on four or five occasions where I have been called on to talk to Kiwanis clubs, when I made the statement of the income there was a terrific amount of interest; the changed attitude of a large number of people who had never considered game management from a commercial angle. The problem is how they could apply it to stock. I went to livestock organizations in a county where 65 cents of every dollar is from livestock and the livestock men could see the range being depleted and I tried to convey to them if in place of livestock they transform it into a wildlife area. We will have to educate our public that the fish and game can be transformed into dollars and cents for the county.

I don't believe game management as you have it in California can be accomplished in Oregon. Some of it is being done. Our big job for protection of deer is to provide winter range and I am glad to tell you that there are among the stockmen some who buy game and fish licenses and we feel there is no real conflict of interest between the stockmen. But we have to educate them to what game means to them and to other groups of men.

We believe if many of us do that, protection of our game will be accomplished and in that way we can get it more or less by indirect methods until the legislature reaches a point whereby we can do what you are doing in California.

Some of it will be discussed more at length this afternoon, especially as regards the propagation of pheasants. No area has been set

aside, but we will, as a result of research being done by the Biological Survey in cooperation with the Wildlife Institute and the Oregon College, get a scientific program in Oregon, but it can not be done until public opinion has made it possible.

The people as a whole think they know more about certain things than the Legislature or our Commission. The program in our State is to get public opinion for us and among our business men to translate it into dollars and cents.

DAVIS: In meeting your public you know things in California are different. The Legislature here in its wisdom has never given jurisdiction to fix seasons, but we have developed this program in spite of that and it is done by popular opinion. The Fish and Game Commission of California has always begged and pleaded with the sportsmen to organize and they are the ones who get the stuff out of the Legislature if necessary. When the Commission determines what is needed, we can depend on the sportsmen going to the Legislature and there is quite a number of them and a lot of votes, so they listen.

Our situation is the same as yours and I think we have been fortunate in developing methods to get along in spite of it. These charts, I will leave here showing the amount of game killed and number of hunters killing them.

In spite of the tremendous number of quail killed, I mentioned over a million, the season is open only six weeks and the bag limit 15 per day, 30 per week, that is only 22.8 quail killed per hunter. On mule deer we have a seasonal limit of one; on other deer, two. The average for the State is about 1.2 deer for each successful hunter.

BARKER: Mr. Aiken, I would like to ask you what is the opposition of the Legislature in Oregon to giving the Game Commission the regulatory powers it needs?

AIKEN: I don't believe there is a real opposition as far as I know. It has never been presented; it has just been accepted that the Legislature would know better than the Game Commission did.

BARKER: Couldn't you enlist the help of your stockmen? It seems the other users of the range are just as vitally interested in giving the Commission sufficient authority. Couldn't you enlist their aid?

AIKEN: I think so, but we have been making one mistake. We have spent too much of our time talking to the sportsmen who are educated but we haven't taken our message to the business men and other users to let them see it is a State benefit.

FINLEY: It is pretty well known, of course, that birds of different species develop according to conditions. In regard to our native species, the question arises as to the introduction of foreign species and the effect. I am wondering whether a study has been made here in California of the effect of birds like the Chukor partridge upon the native birds or whether they are introducing foreign species—just taking the results as they come?

DAVIS: I can answer that. We are very cagey about the introduction of exotic species of any kind or description. In the bird program, I think Mr. Bade will agree with me that the introduction of the Chukor partridge, pheasant or any other species, has been in areas

where they were peculiarly suited and we had no native game. In other words, the Chukor partridge was selected by the State of California for the reason it fills in a gap in an area where it will produce hunting and where there is no native game for it to compete with. We have been careful in conducting studies and watching results on having one species crowding out another.

FINLEY: You know that species does not spread into other territory?

DAVIS: The life history of the Chukor indicates its range and the type of country it will stay in. It hasn't been planted in sufficient quantities to know whether it will spread or compete with others. As far as we can see now there will be a close line of demarcation and there will be considerable space for both species.

HUNTER: You might tell Mr. Finley we have Chukors with valley quail at the Chino Game Farm and there is no evidence of conflict.

FINLEY: The same as with the fish in the streams. We know of a good many streams that have been ruined from the standpoint of native species by introduction of foreign species, and that is a very vital question which needs a lot of study in all of the western states.

AIKEN: Many of you people have studied the Hungarian partridge effect on the pheasant. Some think the Hungarian a competitor with the pheasant. Some say it is not true, but some of the sportsmen report the complete disappearance of all the pheasants in one county.

DAVIS: I can't give you any information as to California because the Hungarian hasn't been successful in this State and we have ceased to propagate it and plant it.

MacDONALD: In Montana we have both and they are very abundant and seem to get along very well in the same area, and in other places we have the Chinese pheasants and in the next county adjacent to them the Hungarian and they prove to be very popular in Montana with the sportsmen. We never noticed any competition.

DELEGATE: Was that true of the Hungarian and blue grouse?

MacDONALD: I don't believe we have any other species. Our blue grouse are up in the timber and the Hungarian in the open field.

FOSTER: Mr. Davis, may we divert from the game? We have heard considerable talk of the striped bass in California and the effect they may have had with your native fish in your rivers.

DAVIS: That's what the lawyers would call a moot question. Frankly I would call it a moot question—any way you answer it, you're wrong. I don't believe we have conducted a sufficient amount of research to say definitely, but taking the life history it would stand to reason it would give competition. Possibly they are the reason for the decline of the run of salmon in the Sacramento and San Joaquin rivers, but I am inclined to think it is somewhat negligible. The decline may have been caused by agriculture. I think what you have in mind is a fear in Oregon of the migration of the striped bass.

FOSTER: They have gotten into Coos Bay.

DAVIS: How serious it might be is a question. I doubt it will give you a very serious problem. I am familiar with the Columbia River and they won't go beyond the brackish water.

FOSTER: They have gotten beyond the brackish water though. They are at the Bonneville Dam.

DAVIS: Well, like humans, they may wander off the reservation. We will soon be able to answer your questions in Oregon as we have just commenced a comprehensive research on the feeding habits, migrations, and life history of the striped bass to carry on where we left off a number of years ago.

DELEGATE: I would like to know what you have done regarding the watering of your birds in the dry areas.

DAVIS: We have done something, but not much. I have a young man who can answer that question. Mr. True, will you tell them what has been done?

TRUE: The only thing done was in a series of quail refuges in southern California, some thirty, all of which are not as well supplied with water as we would like. We have developed it somewhat and supplemented it with tanks, 50 gallon tanks. These are not used during the winter. We have found it satisfactory but we have not tried an artificial supply alone. We use the tanks to supplement the natural supply.

MADSEN: I think one of the most important things any commission can undertake is to determine more definitely the causes for the great fluctuations in pheasants in certain areas. In my own State we started without any pheasants and at one time we had a limited distribution, but they are now concentrated in certain places and no longer exist in some areas where they were once planted. We also have great concentration of valley quail. Something happens after they rise to a certain point to cause their disappearance which isn't traceable to hunters. It seems to us one of the important jobs to be undertaken is an investigation of these fluctuations.

MANAGEMENT OF BIG GAME THROUGH SPECIAL SEASONS

By NEWELL B. COOK, State Game Commissioner, Utah

I just have a few remarks to make here about what we have been doing in our State for the last ten or fifteen years. The State of Utah is somewhat different from other states that have expressed themselves inasmuch as the game commissioner in our State has authority to open and close districts, decree bag limits, etc. The entire fish and game program is in the hands of the State Fish and Game Commissioner.

I am quite interested in the scientific research of the State of California. We are doing without going into research, but we want to ask other States to send their findings on to us so that we can

apply research because we do not have money enough to get it within our own State.

Regarding game management by special seasons, in the State of Utah we have three separate problems in game management. Speaking of big game, we have produced some 100,000 mule deer in Utah. That has been done through game preserves, not in the full sense, however; game preserves used right along with livestock with not one foot set aside for game exclusively.

The buck law has been another factor and then partial control of predators has developed a deer herd from nothing to a splendid one at the present time. We claim, and we quarrel now with the Federal government, that we own the game. In Utah we have 25,000,000 acres of our land under the control of the U. S. Department of the Interior under the Taylor Grazing Act at the present time. We have no range there for State game, so to speak. Then we have our intermediate ranges on which our game herds must winter—about 14 per cent are privately owned, the remainder being intermediate between the national forest and the Taylor Grazing Act, and then we have our summer grazing range that is owned by the U. S. Department of Agriculture through the national forests, besides four sections in each township are owned by the State Land Board. If you find anything there that can be worked out with that conglomeration of management, I can't see it.

I am one of those who believe that this land and all of the organic resources should be under one governing body and not passed to every Tom, Dick and Harry who wants a hand in it. We don't want to turn it completely over to the Federal government, but there must be some halfway ground where we can work out a real management plan.

For 20 years we were very zealous in protecting the female of the deer herd. We taught sportsmen to respect it and we produced that deer herd. Producing it is one thing and managing it after you have produced it is an entirely different question. It became necessary to remove numbers of female deer in congested areas because of the fact they were over-running privately owned property and revenue was not available with which to pay the damage done. The deer were grazing until the foliage upon which they must live was reduced to practically nothing. We then had to revolutionize our entire system and instead of saying to the men to whom for 20 years we had said: "Don't kill the female," we had to turn around and tell them to go down and kill those females. Not being acquainted with range conditions, the sportsmen of our State bitterly resented that move. I think we had over-educated our sportsmen. When we called them in and said, "See here, we will have our regular buck season, and we will have to go into the congested areas and remove the female deer, under special permit," many of the sportsmen bought the permits to save the deer and did not hunt. Many of them did not realize the situation and we went over the range with them. We showed them mountain mahogany, cliff rose, juniper, thousands of acres of it grazed until a deer standing on its hind feet could reach no more. It was hard to show those fellows who did not understand the range that it was necessary to reduce the game.

On the other hand, there was a bunch of sportsmen who took up these permits and went out to remove these deer at the request of the

game department and shot everything that moved. We did not have money enough to man such a hunt properly. We put them out in 15's and 20's and tried to have one man cover the group, but they were lost in the country. Consequently we not only removed in those hunts the necessary number of deer, but our shooting sportsmen killed far in excess of what they should and left them to decompose on the ground.

I am here to learn something of game management when no revenue is available. The hunt has been unwholesome on the morale of the sportsmen. They believe we have, because we had congested areas, an over-population of deer. Consequently we are finding female deer killed and left on the range to decompose in areas where game is very scarce. We have tried various means of checking the permits—bring in so many a day. We have tried in one way and another to get the sportsmen to harvest that surplus of game. I am sorry I can't report it has been successful.

Mr. Davis said he had six million people in California. We have 5 per cent of our land cultivated and that fringes our wintering deer area. Our population is not a factor. We have 500,000 people in our State to kill 20,000 deer.

On the commercial end of it, in 1931 we put out a questionnaire at all checking stations at deer ranges, which we have continued until now. We checked them not only for size and weight, but we checked the hunter and made him show his ticket and advise how much money he spent from the time he left home until he returned for the various things required for the hunt. We proved to the people of the State of Utah that it was the best pay roll that they had in the State. We have proved that deer hunting circulates one and a half million dollars. We have over-educated our sportsmen and now not only the sportsmen refuse to let us handle our game, but the civic clubs have told us we can't kill it so that the bankers and all can have their revenue. I am here now not to tell you how to manage big game, but to ask you how. We have produced a game herd in Utah second to none. Great petitions are filed on both sides, one asking removal, the other protesting removal. With our livestock industry and all of the factors entering in it, the livestock men say to kill them and then you have the civic clubs protesting. We do the best we can with the range considered and we are in trouble all of the time. How can we get harmony and control the situation and do the intelligent thing? I am listening and asking you for any suggestions.

Discussion Led by A J. Martin, Wyoming

MADSEN: I don't know about Newell Cook, he is a pessimistic fellow. I don't want you to get the impression that the difficulties of managing game are such as not to be encouraging. I happened to be in Pennsylvania when they opened the season on does. They had killed 52 hunters and I don't know how many deer up to the time I left. The benefits to be derived from such killing are such to encourage all the game commissioners to ask for authority from legislatures to regulate seasons. This deer season has presented a serious problem, but I do believe that every game commission should have certain

regulatory powers affecting game seasons, and I think it is the only method whereby it can be done successfully.

COOK: I am not discouraged.

AIKEN: In your checking, do you check rifles and deer? I had a report from the warden telling number of deer killed and method and we suggested if you could tell by firing a rifle into a block of wood you would have ballistic evidence.

COOK: We don't allow anything smaller than 25-35 to go on the range, but that is as far as the check is concerned.

MARTIN: I would like to state that Wyoming has such a law and the law reads the bullet shall not be less than 23/100 of an inch in diameter, the cartridge and bullet 2 inches over all, with soft point bullet for big game. That does away with the smaller bore guns.

While I have the floor, I wish to concur with Mr. Cook in his point of view on game management. I think if any State has all the complications of the rest of the states, it is Wyoming. We are up against the factor, not of the sportsmen, but of everyone. We have livestock and our summer range is sufficient, but we are shy on winter range that Cook is talking about. When winter comes, 90 per cent of our game, especially the deer, is on private holdings. That condition exists and we have the same trouble he has in disposing of it.

You people mixed up with the livestock business all appreciate what I am going to say about the elk. It was those herds of elk fed and babied and taken care of that have been a trouble to the game department. For years they have been a source of nuisance to livestock men and they wanted to get rid of them. We got quite a lot of criticism from everybody, especially home people, but it was to the effect that they killed everything, bulls, cows and calves, which was a fact, but it was in the very heart of the winter range, and during the kill they got rid of the particular elk it was necessary to get rid of.

Our elk herd went through Jackson Hole in better condition than in former years. It had a tendency to put them back on the range where they belonged and during that we had two winters. The elk weathered them all right and when we thought they were backing up again, there came another winter and they went through that. It is the public we are fighting more than the game. We need solely a winter range.

BARKER: We are all here to learn in this matter.

FINLEY: I never thought at one time we would have an open elk season in Oregon, but we had one during the past two years. The State has not enough to hire wardens, but it has been done in a splendid manner in cooperation with the U. S. Forest Service—the two together worked it out far better than we thought it could be done. I don't know what it has been in other states.

BARKER: In our State, they have helped us.

COOK: In Utah, it would take the army to help.

BARKER: Any other discussion? I would like to say one word on what we have done in New Mexico in special seasons on antelope. We have nice herds in different parts of the State, not more than

10,000 all told. They have increased three to four hundred per cent in the last ten or twelve years and they are doing very well. There is no reason why we should not be taking mature bucks, and we have handled it by issuing so many permits, charging a fee of $5 in addition to the regular license, which is enough to pay the cost of supervising the hunt. We have only killed a limited number, not as many as we could spare, but we are trying to supervise and so educate the sportsmen and public so that they will see we are managing and not destroying their herds.

The first year we advertised that we had 300 permits to sell; the sportsmen refused to buy the permits as they had protected the antelope and their organization had paid a reward for conviction for killing antelope. All they could see was that the Game Commission was going to tear down in one season what they had been doing over a period of years. As a result, only 64, 16 of whom were non-residents, purchased permits when we advertised for 300. However, each one of them got a nice antelope buck and during the entire season there were only five violations of the law. We got by in excellent shape. There was no kick-back. They came back with high praise because we supervised the hunt. It cost all we got and more, but they went back satisfied. The following year we sold all the permits but not everyone got his animal. The third season we also sold all permits offered.

I am now getting requests to know if we will have an antelope season. If you can prove to the sportsmen that we are not going to destroy what they consider "their game" they will cooperate.

CALIFORNIA'S JUNIOR GAME PATROL

By A. T. Jergins, Fish and Game Commissioner, California

A short time ago I had an opportunity to visit one of our prisons here and in that prison I never felt so ashamed in all my life. I found something like 6500 boys, the average age of 22 years. Now when we gather in a group like this you invariably find the men say we haven't money to do this nor wardens to do that. I am going to give an illustration of what I initiated some three years ago in a city of 50,000 people in which juvenile crime was so bad we could not keep chandeliers on light standards.

This town is located in a district entirely surrounded by other cities, there is no distinct boundary between them. The chief called me in and said: "Jergins, what am I going to do? We have only so much money and I just simply can not take care of them." I said, "Let's try a scheme. The only difference between men and boys is men are grownup boys. A man craves the same things as a boy." Now I don't presume there would be a man in this room today if he did not feel he was doing something for his fellowmen and for the preservation for posterity of fish and game life of our country. I am speaking not alone of us who occupy positions without salary and devote as much time as any man can possibly imagine.

We went ahead and organized a junior detective force. Starting in this town of 50,000 people, the crime in that town has almost

become nil. We have 4700 detectives and it does not cost us a penny. If a house is broken into, if an automobile is stolen, you would be surprised with the little kindness and teaching, how much work and how much good these boys accomplished. They are everywhere. They take just as much pride in that little 12½-cent badge as you would in your diamond studded badge. Therefore, I am preparing a setup to establish in the State of California a junior warden class of junior wardens of boys from eight years up in which the wardens of the various districts will give at least one evening a week in their respective districts and call in these boys and teach them what it means by killing a hen pheasant. For instance, a short time ago one of our wardens at Marysville saw a boy kill a setting pheasant with a .22 rifle. Instead of knocking the boy over and arresting the lad he went to his father and then to the school. This was an excellent opportunity to teach the entire lot of boys a lesson bringing in the eggs ready to hatch and showing the whole class how many pheasants were killed when he did not realize what he was doing. You would be surprised at the effect of that illustration. It did more good than any other lesson in the district. I really believe that if that rule were adopted it would be the answer to all questions about your inability to control out of season shooting. If we could just universally start a school for junior wardens, give the boys a little badge and once a year give them a picnic or barbecue, I think it would be doing a great deal towards stopping the 100 per cent overcrowded conditions in our penitentiaries.

PROGRESS IN ADMINISTRATION OF THE PUBLIC DOMAIN

By G. M. Kerr, Division of Grazing, U. S. Department of Interior

It is a great pleasure to me to be present. For that reason I am extremely glad that Mr. Molohon could not be here although he was very disappointed at not being able to be with you.

The Taylor Grazing Act became a law June 28, 1934. The purpose of this act was to stop injury to the public domain, public grazing lands, due to overgrazing and soil erosion, and to provide proper regulation of the public ranges, improve, develop them, to stabilize the livestock industry dependent on that public range and introduce different seasons thereon. As most of you western men know, the public domain that came under the administration of the Taylor Grazing Act was the leavings from years of settlement and appropriation of one sort or another, national parks, forest service, reclamation, homesteads, etc. For a number of years little interest was shown in the use that was being made of that land. No one took it upon himself to supervise its use in any way and as a result the man on the ground, the stockman in most cases, was the only one that could and did use the public domain as an individual. We had of course the game which, because of overuse of the public domain by stock, was being driven back to the higher ranges, other areas and sometimes into oblivion.

With the passage of the act, however, there was immediate interest taken in the public land by various agencies who apparently were

content or had simply failed to see the possibilities, and as a result several million acres were requested by this bureau and that and it has complicated the situation quite a good deal. Our problem, however, has not been the settling of that so much as it has been getting the Taylor Act actually into operation. In this administration in order to provide in so far as possible a proper use of the public range, a use to the best interests and advantage of those people who were dependent upon it, the act provided and the department agreed to the setting up of advisory boards consisting of men who were active livestock operators and could be relied upon in the granting of permits or licenses under the act. These boards were elected by the people of their various districts. It is well to bear this type of operation in mind when you consider the problem of game management in connection with the public domain.

In the original act 80 million acres were set up as a possible grazing district, about one-half of the actual public domain area. As a result, 37 out of a possible 52 districts have been set up. Advisory boards consisting of from 8 to 23 members were elected and have passed on applications, considering them and making recommendations. In these 37 districts there have been in the neighborhood of 15,500 licenses recommended and the licenses involved approximately 1,600,000 cattle, 6,000,000 sheep, 150,000 horses and 200,000 goats. These advisory boards have only recommendatory powers. Their recommendations must be fair, must be reasonable and must be according to the provisions of the act. The secretary and the Department of Grazing, of course, reserve the right to accept or reject recommendations made by the advisory boards.

In the amendments passed in the bill by the last session of congress the 80 million acre limitation was raised and we are now permitted to increase the acreage to 142 million acres. There is some question as to whether all of the 52 grazing districts originally recommended by stockmen will now be set up. We follow the principles in the original meetings of going to the people in the districts or proposed districts and giving them an opportunity to either accept the offer to set up a grazing district or to refuse it. These districts are not forced on the people, at least not at the present time.

In line with that we are holding meetings in Wyoming, Montana, Idaho and Nevada. Those meetings are to take care of the big bulk of the public domain in that area. Two districts in Arizona, one in Colorado and an additional district in Oregon might possibly be set up later.

On the results of this work of the last two years looking in a general way at the work accomplished, I think we have something to be proud of. Certainly we have done a tremendous amount of work. In the range improvement we are disappointed, and probably will be for some years to come. Any ranges that are as sadly depleted as many of these are will take a long time to be brought back to original or near original condition. We are working towards that just as fast as we can.

In the first licenses granted in 1935, all nomadic stock was eliminated. In the past spring and summer meetings at which spring and summer applications were considered actual cuts were made. These cuts, however, were not as large as are needed and we will have to make additional cuts which we know, but fine points of actual man-

agement will require detailed supervising of the public ranges themselves as well as the properties which the stockmen are using and which they must have in order to get a license or permit under the Taylor Act. I think we have a program of range and property supervision going on at the present time, not moving too fast, but moving, and with each district in which work is completed we will be able to go ahead and get the stock on the range somewhere near the actual carrying capacity. In New Mexico and Arizona allotments are being worked out this summer. In some other districts allotments are enough advanced so that by the first of the year short term permits may be issued, but they can not be issued, however, until we get nearer the actual carrying capacity of the range and stock reduced to that capacity.

Now as to the administration relating to wildlife—that is one thing we were confronted with immediately upon starting out with the administration. At the beginning, application had been made by the Biological Survey, for, I believe, eleven game refuges covering some ten million acres of land. Since that time six additional have been proposed. Many of them have been approved, all of them have some land not on public domain, and others are outside of grazing districts over which we have no control. The only thing in those states is to assist as much as possible the Biological Survey or any other agency in getting direct boards through which they must go. In New Mexico there is a conservation plan working out which we feel is the ideal setup as far as game people and the stockmen are concerned. If the wildlife people and stockmen can be brought together on common footing, something can be obtained. If not, there is going to be a gap which will never be spanned. It will be necessary for you people to get together before we can hope to do an intelligent job as far as your game problems are concerned. The bulk of the stockmen are not antagonistic to game. Some are, of course, hot. If we could keep those hot stockmen and hot wildlife men out of it, I think those less hot might work out a satisfactory understanding. But bear in mind the process that we follow in presenting our problems to the advisory boards, getting their recommendation. Here would be the plan that we would follow in cases of game problems. Suppose one of your state commissioners wants certain areas set up for some particular species of game. Your recommendation or application would have to be presented to the advisory board. If you come with a general recommendation that deer be protected, we can not do much with it. Stockmen will not consider it seriously. If by using your knowledge of game problems and your game refuges you can work out a plan and come to the advisory board and say, "We want preference given to 5000 deer in this particular district, it is the natural range for them and they will cover a certain territory." We can work with that. I don't think it would be any question but what this could be worked out to mutual satisfaction. Preference is given in the case of the Biological Survey to refuges that have been set up. There is dual control there and preference is given to the numbers of game that were set up by the Biological Survey in dual and cooperative work on various refuges. They were given first right and after they are taken care of whatever is left is distributed among livestock. We can work out the same thing on game problems.

In New Mexico where they have a representative on every advisory board they were given an opportunity to have the livestock men on the board, and in this particular region they can present the game problem much better than the game men themselves. If we had an organization where we could employ enough game men we could work out the problem, but we have not and there is no hope for a long time before we can get it. In the meantime we can not stand still, but would recommend to the commissioners that you follow the plan similar to New Mexico along that line. I am sure if you do that, our problem and your problem would be greatly facilitated.

Discussion Led by Amos Eckert, Idaho

ECKERT: I am very glad to hear the talk that Mr. Kerr gave on the Public Domain. I know we are all interested from a game standpoint and other ways. We have 10 million acres of Public Domain in the State of Idaho. There is a question in there that seems to me might be clarified. I might say I am interested in the Public Domain both by game and stock reasons. I might mention first in the commensurate standpoint we feel we should have commensurability with game as well as livestock. We have one district already in the State and I have a right to run stock on the first district. I had to reduce such stock 25 per cent on the law of commensurate right. Dropping over to the game side, they should have a commensurate right from some standpoint, but I don't believe it has been mentioned in the Taylor Act. I have gone among stockmen and they believe we should have commensurability with the game; have that priority right and blanket consideration. Some stockmen and game men are opposed, but if we could insert in the Taylor bill a provision as to whether we have that right it will overcome future trouble. I am not talking contrary to either way because you can see my problem as I have cattle on the range. I had to reduce 25 per cent and was glad to do it. Dropping back to the game managing plan, if we could have an area set aside under the Taylor bill in the Public Domain, a small tract administered by the State, the surplus could be removed or scattered out and I know it would be appreciated by the sportsmen and a lot of the stockmen.

Getting back to the game managing plan, we have no game commission in Idaho and I happen to be the game warden there and once in a while I have to get up on my hind legs and talk out. When I first came in we had game refuges and preserves. We were growing game with no way to market it or harvest our crops. We asked the legislature to make it so that the game warden could open any game preserve or elsewhere for a limited number of game under a drawing permit where investigation showed the game should be thinned, removed or scattered; the numbers to be designated by the game warden for removal and return to the Public Domain.

We are limited on winter ranges practically all over the State. I might mention our 4000 antelope in one district which has not been open for years and where the winter range is rather limited. Three years ago we decided to remove 150 bucks, which we did through a drawing for permits. We put out a call for applicants and issued licenses to the lucky ones. Without this removal of bucks the herd would have been exterminated owing to lack of range. We have continued these

hunts and are going to have six special hunts this year. I think if you are going to harvest a crop, our way is the best.

Regarding the Taylor Grazing Act, we will work in harmony if they will give us blanket consideration for certain areas.

AIKEN: In arriving at commensurability under the Taylor Grazing Act, is it a fixed quantity or is it to grow, or the wildlife to increase? In other words, assuming the Taylor Grazing Act will do what it should bring back the range and the present capacity of livestock double or remain fixed, while the livestock industry gets the benefit. How are we going to arrive at commensurability?

BARKER: Two times zero is still zero. On lots of the public domain land at the present time the game is pretty near to zero and in my opinion on such areas we are certainly going to have to increase the game although you may be decreasing the livestock in order to bring back the range. In New Mexico the game is entitled to a reasonable use of all of the public domain land, you can call it commensurability if you wish, by virtue of the fact that it was there first and would still be there if it were not for range depletion or some other factor. It is entitled to the use, to a reasonable extent, of all public domain land. That is the heart of our plan which has been recognized by the Secretary of the Interior, and which we are operating under. We state definitely what our objective is. For example, if we have a grazing district, let's say, of 1000 sections of land in it that are suitable to the grazing of antelope, we state in our plan what we propose to do. We propose to raise one, two or three antelope per section and so far the stockmen have agreed to the objective.

The areas are so vast in all of the Public Domain that even though you don't have a high number per section, you have so many sections of good range that if you get two or three per section you have more antelope than you need. For instance, we have one little grazing district—the south central district—where I believe there are 1200 sections of good antelope range. At the present time the herds will figure about one-third antelope to the section. Our objective is to build that herd up so that it will be 2½ antelope to the section. In other words, 3000 antelope is the objective on that range and the grazing district accepted that as legitimate. The stockmen do want to know definitely what we are going to do. They don't want generalities.

Many of the commissioners have interest in the Public Domain. I would like to hear more on this before we pass on. Any questions you wish to ask, Mr. Kerr will answer.

COOK: New Mexico seems to have an entirely different setup of livestock men than Utah. When you set up your grazing board, you have the right to appoint your members?

BARKER: Yes, we have that right.

COOK: Where did you get it?

BARKER: Through a regulation, based upon our recommendation, of the Secretary of the Interior, just as other rules are fixed under the Taylor Grazing Act to administer the Public Domain.

COOK: In Utah we have grazing districts set up upon the recommendations of the livestock men to the committee.

KERR: Except that in New Mexico, the plan had been worked out as you remember, in February, 1935. The plan was discussed and presented to the Secretary at that time. That plan was approved for that State, and a similar agreement has not been drawn up for the other states. Until it is, it will be impossible to appoint a game man to any of these boards. As soon as it is drawn up and accepted, you can appoint representatives to each of the boards now operating in Utah.

COOK: What I am trying to get at is this: I don't believe the federal domain will ever be restocked by appointing committees of sportsmen, or livestock men, or any other people who deteriorated that range and ask them to bring it back. I don't believe it can ever be done.

KERR: By inference, Mr. Cook, I want to assure you it can. As I said, the recommendations of the Advisory Board must be reasonable, fair and according to the act. They are held by those three things. If a carrying capacity of a grazing district is 1000 and they want to make it 2000 they are unreasonable. We will get the carrying capacity down and in the same way get the consideration of your public.

COOK: Living up to the spirit of the act, has the Secretary of the Interior lived up to the act by Congress in which the Secretary set up committees of landowners and livestock men?

KERR: He has not set up you state men, no. I don't think that it is required under the act that he do that.

COOK: Then it does not mean what it says. Another question occurs to me. Elliott Barker has a bunch of livestock men who work with him. You know my livestock men. We try to get wildlife men and appointed committees, including the secretary of the Wool Growers' Association, cattlemen's association who would not stop to organize such a committee. As soon as they hear what we have to say, they resign. They won't cooperate. I maintain it is the duty of the Secretary of the Interior through the Grazing Department to live up to the spirit to organize such a committee.

KERR: We can do it. We are empowered to do it, but can we do it as well as you can do it yourselves? That's the thing we are wanting to get—your ideas and then work it out according to the plans that are in your judgment the best.

COOK: You were at Denver when our little group of game commissioners were there with the livestock men ready to organize. When I asked the wool growers and the stockmen would such a plan as the New Mexico plan work in Utah, I was very plainly told "no." They said, one head of game is one too many. All I am asking is, is the Secretary of the Interior to say where you are to have a new member in your family? We have a game man ready to talk as to whether this act allows him or not. What are we going to do with a problem like that?

KERR: There is no question but what the problem in Utah is much more of a problem than in New Mexico. In the first place, as Mr. Cook said this morning, he indicated there are more sheep in the State by a good deal than should be there for the good of the private

land, forest land or public domain land, and it will be hard to work out a plan similar to the New Mexico plan.

COOK: I wish you would appoint that committee and you would at least hear us.

MARTIN: Mr. Chairman, I think our conditions in Wyoming are practically the same as Mr. Cook is talking about. The only difference is we have a wildlife organization, but it wasn't through the stockmen we got it. It was from the fact that the sportsmen did the organizing and our State is organized under districts. There is no organization of districts with the exception of one livestock district set up in Wyoming and that is in a locality where our game is not affected. It doesn't affect our game in any way, but we are fearful of the time when it is set up so that it will affect our antelope.

We have a peculiar situation there. We have three antelope districts in the State: the Red Desert herd, the eastern Wyoming herd and the Park County herds. The Red Desert herd is in a peculiar situation as a lot of it is on land owned by the railroad company and leased by stockmen. Every other section the government claims, so there is a question we are up against—how we are going to get along with our antelope herd on that?

Our other herd in the eastern part of the State is on privately owned land taken up by the dry farmers. I might say with the thousands of antelope running wild and getting along fine and then the stockmen and now the dry farmers are fighting our antelope, we have no chance with them there whatsoever. There is a move now to take that land out of circulation and give it back to the government, but we have no information on that and so don't know how to work on it from that angle.

In getting back to the Park County herd, it is on private property and that is another angle we have to thresh out among ourselves. We are not thinking of the Taylor Grazing Act. We can't get any assurance of where we are going to work. This Rock Springs meeting you just spoke of is the nearest I ever heard of anything and I didn't know of it until today.

MADSEN: I want to ask Mr. Kerr a question, which I don't know if he can answer. In carrying out the provisions of the Taylor Grazing Act, you first take into consideration the condition of the range and what its growing capacity is. You then consider the number of livestock on the range and the people who own and graze them there, and their community property. All that you have done. I mean you are in the position of doing. In bringing this about, you meet with cattle and sheep growers individually and collectively and you carry out that part of the act. Is it also your responsibility to contact and cooperate with other citizens of the State with a view of establishing game in the proper percentage on that same range?

KERR: I wouldn't say that the act specified we should. It says game shall be protected.

DARLING: May I introduce just a sentence? When it came to the regulation of game we found that the Secretary of the Interior might make such regulations as he thought necessary to conserve natural resources which we all thought included game. Upon investi-

gation, the Attorney General ruled that natural resources did not include wildlife. There is no such regulation in that bill.

BARKER: It says the Secretary of the Interior shall by suitable rules and regulations provide for cooperation with state agencies interested in the propagation and protection of wildlife. If I may add an additional phrase, I think the final responsibility to provide those regulations certainly is with the Secretary of the Interior, but Mr. Kerr has said the Department of the Interior is short of help and doesn't have the men, and if I were a game commissioner, I would ask the help of the sportsmen and stockmen, and I would write out for the Secretary's signature, a regulation for what I wanted and put him on the spot and make him either sign it or give a counter proposal. He would have to accept it or turn me down. I would like to see these other commissioners here write out regulations as to what they want the Secretary to sign and put it up to him. You may not get what you want, but you will put him on the spot and you will get something. It may be "no" but you will know where to get something else. We worked for what we got in New Mexico, but finally he signed on the dotted line. If you all know what you do want and what regulations you want and will write it out and put it square up to the Department, you will get somewhere with it.

AIKEN: We have a state grazing district, the Jordan Valley, that operated under the State law two years prior to the Taylor Grazing Act, known as Oregon District 4. Grass has come back as a result of the regulation. Much growth can now be found which was not there for the previous 15 years. It will bring grass back if properly regulated. Weather of course makes a lot of difference. What we want to know is whether wildlife is to be regulated in the increase, or is to remain stationary and stagnant.

MARTIN: I do feel like they can bring the grass back with regulation, but my thought of wildlife on this same area is where there isn't enough grass on the area to support the game, they are overgrazing.

FINLEY: May I ask in the New Mexico plan did you ask for any area to be set aside solely for the conservation of game?

BARKER: No, we haven't asked for specific areas. We asked that on areas of the highest value for wildlife that preference to wildlife shall be given on those areas. The wording is very similar to the preference program Mr. Darling had on his Biological Survey setup.

FINLEY: Suppose there is a certain area you want to conserve for antelope and you prefer to have it set aside—don't you think there should be a certain amount in these hereditary ranges set aside solely for that?

BARKER: Yes, if there is a need for it.

FINLEY: How do you get it in that case?

BARKER: I said a little while ago, we didn't plan for any specific areas. The game management plan is not complete. We are asking for a big area for mountain sheep and the grazing district told us we could have it.

FINLEY: Solely for mountain sheep?

BARKER: With a limited amount of cattle, your mountain sheep will be given preference, and an area surrounding it 10 miles in width will be maintained perpetually against the use of domestic sheep and devoted to cattle only because of disease our domestic sheep may transmit to the mountain sheep and they have agreed to devote that area primarily to wildlife. It hasn't been formally approved and it is not quite complete, but it has been discussed often and they have unanimously agreed to our proposal.

FINLEY: We have been unable to get through the Hart Mountain antelope range as we wanted. I understand there is one area set aside in Nevada for the protection of mountain sheep, the only area in the country set aside solely for that purpose. We would like to have certain areas set aside solely for that purpose.

KERR: On that Hart Mountain reserve, the plan as originally set up was a refuge similar to the others where the Biological Survey and the Division of Grazing would administer it and there would be different uses. That plan was approved and then the plan was changed and it is now to be solely used by antelope. This plan is now under consideration.

MACDONALD: Under the plan, how much consideration are the sportsmen to receive from these boards? They are outvoted 5 or 6 to 1.

BARKER: Yes. They are outvoted when it comes to an actual vote. Of course, they wouldn't have a majority because that would be among the stockmen.

MACDONALD: Is the migratory wildlife to be given any consideration in these districts?

BARKER: Yes, the regulation approved by the Secretary makes that mandatory.

MACDONALD: That they give some consideration to wildlife? We have endeavored to work from the bottom up, but have not been able to accomplish anything at all. We have one man administering grazing in the State and we have asked him to let us know when the meetings were held or to be held and the district set up, and he has been very evasive and he finally popped up and said the trouble with the sportsmen is they are valuing the wildlife too high. Shortly after that they held an indignation meeting. Our best plan would be to accept your suggestion and start from the top down.

BARKER: I think you have a basis for it there.

MADSEN: Mr. Chairman. I would like to know if this group believes there can be such a thing on a desert area of this country as a dual use of range by domestic sheep and wild sheep? I think it is agreed they are incompatible. In the next place, when every sheep herd of two or three thousand head is known to take every spear of grass there is, wouldn't it be better to designate certain areas where you might have a nucleus of a sheep herd or antelope herd? I doubt the practicability of the use of domestic sheep and mountain sheep. Here's Utah with 84,990 square miles and not one square mile set aside for the use of game. Shouldn't game have its spot all to itself?

BARKER: We might state we agree with you absolutely in so far as mountain and domestic sheep are concerned. They can not use the ranges jointly.

REPAIRING THE DUCK FACTORY

By JOHN C. HUNTINGTON, Vice President, More Game Birds in America, a Foundation

Members of the Association of State Game and Fish Commissioners and guests:

Your President, Elliott Barker, has asked me to present my views on the future of the grand old sport of duck shooting in the United States. I had hoped, and sincerely wish, that I could do so personally and that I could be with my many friends among you to discuss this international problem. However, even though we are 2600 miles apart I want you to know that that represents distance and not sentiment.

Less than six years ago—on October 1, 1930—a small group of eastern sportsmen after a careful survey of the field decided to found a new organization the sole purpose of which would be to work for the restoration of game birds along the same sound lines which have proved so successful in modern business. From the very beginning the Foundation put its staff to work on the problem of duck restoration.

Our first job was to find the facts. This was done by a study of all available data and contacts and correspondence with people well informed on the subject. The next step was actual field work which has been practically continuous since 1932. This field work has taken representatives of the Foundation through the breeding grounds of northwestern United States, where in former years millions of ducks were bred each year and which today constitute a practically negligible factor in the annual continental duck crop.

Representatives of the Foundation have covered practically the entire Canadian duck breeding range in the southern portions of the three prairie provinces, Alberta, Saskatchewan and Manitoba, and during our work on the international wild duck census last summer we observed the ducks as far north as Great Slave Lake in the Northwest Territories.

Four members of our staff have seen more of the great prairie duck breeding grounds in western Canada than any four men living today. I say this simply to illustrate the thoroughness with which the Foundation endeavors to find the facts. It is true that others, including men from the U. S. Bureau of Biological Survey, have observed Canadian duck breeding conditions—some of them for quite a few years—but so far as we know our work in the northern areas last summer constituted the first systematic effort to ascertain the conditions of duck breeding grounds and duck populations in the vast wilderness north of civilization and the further fact that other observers have traveled by boat, canoe, and horseback whereas planes were used exclusively in our work.

The country roughly north of the fifty-third parallel in Alberta, Saskatchewan, and Manitoba and south of Great Slave Lake is for the

most part heavily wooded and extremely well watered. The airplane offers a birdseye view of such vast dimensions that hundreds of square miles can be minutely examined in hours. If our work accomplished nothing else, it proved conclusively that it is entirely possible to locate duck breeding areas from the air and to ascertain the population of large areas with great accuracy.

This country lies north of the end of steel and is inaccessible by any other means except steamer or canoe and, in a relatively few cases, on foot or horseback. It must be obvious that the airplane is the only practical way to investigate these areas, many single units of which would require literally weeks of travel overland and by canoe to visit.

For observation purposes our planes flew at an average height of 300 feet and much of the time flying was done well below 100 feet. In the most productive areas vegetation is extremely sparse and old ducks and their young are clearly visible—easily distinguished at any height below 200 feet without the aid of glasses.

The interesting facts developed by the international wild duck census are these:

The prairie region which includes North and South Dakota, western Minnesota, parts of the three provinces lying between the Rocky Mountains on the west and that great rock formation—the Canadian Shield—on the east, and a small portion of the Northwest Territories lying south of Great Slave Lake, had a duck population of 39,700,000 in August, 1935.

The distribution of these ducks during the breeding season is important. For example, of this total only 2,200,000 ducks were found in North and South Dakota and most of Minnesota. In the southern portions of the three prairie provinces—in what is commonly known as the Canadian wheat belt—the duck population was 5,600,000. In the northern triangle of which the fifty-third parallel is the approximate base and Resolution on Great Slave Lake the apex, the Rockies on the west and the Canadian Shield on the east, forming the sides—an area of roughly 240,000 square miles—the duck population was 31,900,000.

As many of you gentlemen know, there are other important duck breeding grounds on the North American continent, including those in Alaska, the delta of the Mackenzie River, Fraser River Valley in British Columbia, and the black duck breeding grounds of the maritime provinces of Canada, but it is a fact that the bulk of the ducks which annually visit the United States are produced in this great mid-continent breeding ground that we are discussing. While no one can say positively that this has always been true it nevertheless is a safe assumption that this area has always produced the bulk of the continental duck crop.

The ducks which breed in this vast prairie area, together with those which breed still farther north but migrate through the area, spread out fanwise during their fall migration and cover practically the entire United States.

In recent years we have heard many explanations for the decline in the continental supply of ducks—over-shooting, drought, natural enemies, and drainage—are familiar terms whenever the duck decline is discussed. The chief cause of the tremendous decrease of the number

of ducks on the North American continent—the cause which far surpasses in its effect all others combined—is, however, the encroachment of civilization on the ancestral breeding grounds of waterfowl. It should, therefore, be obvious that the only remedy is the restoration on a vast scale of the breeding grounds which have been destroyed and which are vitally necessary before any of us can view the future of our ducks with any degree of confidence or satisfaction.

Two generations ago most of the Dakotas, parts of Minnesota, Montana, and Nebraska and the southern portions of the three Canadian prairie provinces constituted a vast waterfowl nursery which each season produced countless millions of ducks. Today most of this area is devoted to the production of crops. The potholes, the sloughs and the marshes which used to constitute the wild duck factory are gone. In recent years, drought has laid a heavy hand on the pitifully small numbers of ducks which tried to reproduce their kind in the few remaining water areas. Many of these small bodies of water have dried up after the birds hatched but before the ducks were able to fly.

The Bureau of Biological Survey is now restoring large areas of former duck breeding grounds in the United States. Undoubtedly Dr. Gabrielson will tell you of the splendid progress being made in the restoration of water areas for ducks in the northwest. The Foundation takes particular pride in this program because the funds now being used resulted from a memorandum presented by us to President Roosevelt and because the program under which the Survey is now working was formulated by the President's Committee on Wildlife Restoration, of which Mr. Thomas H. Beck, a director and member of the executive committee of More Game Birds, was chairman.

The Foundation loaned four members of its staff, without compensation of any kind, to the federal government for a four months' period and, as a result, many of the projects which are producing ducks today for the first time in years were worked up in detail by members of our staff. Sportsmen in all parts of the country should bend every effort to see that this program of land acquisition and development goes forward without interruption and by that I mean that the necessary funds be made available in the years immediately ahead. After these areas are acquired and developed to their full producing capacities the Biological Survey should receive annual appropriations to provide for their upkeep and management. This is a job in which the Biological Survey should have the wholehearted support of every thinking sportsman who is sincerely interested in the welfare of waterfowl.

Much of the former duck breeding grounds in the United States is, I regret to say, no longer available either because the cost of acquisition is too high or the cost of restoration prohibitive. While the present program of the Biological Survey should be prosecuted to the full extent of its possibilities, I believe that everyone who has studied the subject will agree that maximum development of every possible breeding ground in the United States can never again produce a decent fraction of the demand for ducks on the part of the million duck shooters of the United States. This fact is clearly illustrated by the figures I cited a few moments ago:

2,200,000 ducks in our three best northwestern states in 1935

5,600,000 ducks in the southern portions of the prairie provinces.

31,900,000 ducks in what we term the northern Canadian breeding grounds.

Granted that the production of ducks in the United States can be greatly increased to an eventual total of ten, fifteen or even twenty million ducks per year it is perfectly plain that even if the latter figure is ever reached, which I personally am inclined to doubt, we still must look elsewhere for an annual crop of ducks sufficient to warrant the continuance of duck shooting as a sport in the United States. The logical place to look is to Canada.

The northern Canadian breeding area which is today producing 50 per cent of the entire duck crop of the continent is still a virtual wilderness where droughts are unknown. If it were to remain in its present state, we could depend upon Nature to send south each year approximately the same number of ducks which it has done over the centuries. But there is no guarantee that this happy situation will continue. Already civilization is creeping northward. In our work last summer flying over vast forest areas we frequently saw clearings made by farmers who, for one reason or another, had left the wheat belt and gone farther north. The Canadian government maintains an excellent fire patrol service over much of this area, but destructive fires still do occur and when the timber is gone the water will not long remain. If some natural calamity such as an epidemic disease should occur in this northern portion of the area during the breeding season, the end of ducks and of duck shooting would be a matter of only a comparatively short time.

The southern portion of the Canadian prairie area offers tremendous possibilities for the production of greatly increased annual duck crops at comparatively small expenditure. The present annual production can be trebled, quadrupled or still further increased simply by the restoration and competent management of duck breeding grounds.

After careful study of the entire situation, weighing all the facts, the Foundation has reached the conclusion that the future of duck shooting as a sport in the United States is absolutely dependent upon preservation of the northern breeding grounds and restoration of favorable duck breeding conditions in the southern portions of the prairie provinces.

It is true that a so-called "wet" cycle would result in an increase in the Canadian duck crop but such results would be meagre and temporary for the simple reason that man has so thoroughly destroyed the former breeding grounds of ducks that Nature unaided is no longer capable of mending the damage.

Figures recently assembled by the Foundation indicate that sportsmen have invested well over one hundred million dollars in club and private duck shooting properties in the United States. This represents the cost of land and buildings alone and does not take into account the equipment which every duck shooting property must have. Are the duck shooters of the United States going to sit by and see this investment fade away when at comparatively small cost they can assure its permanence and, what is even more important, in my opinion, continuance and steady improvement of the grand old sport of duck shooting?

Will Canada cooperate in rebuilding the duck factory which is now virtually in ruins? Emphatically yes! Prominent government officials, businessmen, fish and game associations and natural history societies interviewed during the past month have enthusiastically endorsed this program and promised complete cooperation. Canada does not have the money to do the work herself and there is no good reason why she should pay the bill for improving duck shooting in the United States. We are the beneficiaries of the duck crops produced in Canada and yet Canada is perfectly willing to meet us half way if the duck shooters of the United States will subscribe the necessary money which represents less than one-half of one per cent of that invested in duck shooting properties of this country.

A detailed program to end the duck depression will shortly be put before the sportsmen of the United States and, unless I am very much mistaken, the necessary funds will be promptly subscribed. Dividends in the form of increased duck crops will shortly thereafter be payable to the duck shooters of every state in the Union.

Longer open seasons, larger bag limits and the repeal of petty unenforceable shooting regulations with which the sport of wildfowling in the United States is now afflicted will be possible.

When this program is announced I trust it will receive the active interest and financial support of everyone who is sincerely interested in the future of duck shooting.

A PROGRAM OF WILDLIFE RESTORATION AND REGULATION ON INDIAN RESERVATIONS

By Roy Nash, Superintendent, Sacramento Indian Agency, U. S. Department of Interior

Mr. Chairman and members of the Western Association of State Game and Fish Commissioners: I am keenly aware of the disappointment this assembly must feel in the circumstance that wildlife regulation on Indian reservations is not to be discussed today either by the Hon. John Collier, U. S. Commissioner of Indian Affairs, or by Mr. Robert Marshall, his Director of Forestry. Your chairman requested an official and authoritative statement of the Indian Bureau's "plans both for restoring wildlife habitat and wildlife itself and the regulation of hunting by Indians on these Indian lands." Commissioner Collier is down in Old Mexico and Mr. Marshall, when last heard from, was in the tall timber of Oregon. When both the Commissioner of Indian Affairs and the Chief Forester found it necessary to decline your cordial invitation, your president requested an authoritative statement of policy which might be read by me for the Commissioner; in this he likewise was doomed to disappointment.

I am going to be very frank with you. I have a suspicion that the reason for your disappointment in both the above respects is the same: the Indian Service has no definite plan for restoring wildlife or for the regulation of hunting by Indians on Indian reservations. It is high time that the federal government should have such plans. This afternoon I will attempt to formulate the problem.

Throughout the West today there is effective, on the whole, a pretty sound and intelligent public opinion in the matter of game conservation. National parks, wilderness areas, and breeding grounds have been set aside, within the boundaries of which no destruction of game is permitted unless the area becomes overstocked. All states have laws specifying definite periods within which hunting and fishing of most species are permitted. The game hog and the man who killed elk merely for the teeth are no longer respected members of any western community. The idea of game management, as expounded by my old colleague of forestry days at Yale, Aldo Leopold, gradually is taking hold. The man interested in conservation of wildlife travels the West with a feeling that all is well, or at least getting better—until he enters an Indian reservation. Then his optimism suffers a rude shock.

To make it concrete, suppose he comes from the south entrance of Yellowstone Park and takes the road toward Lander, Wyoming. South of the park he is certain to see deer, many elk, possibly a moose; in the Tetons, mountain sheep. But when he enters that magnificent expanse of territory called the Wind River Indian Reservation, he enters a region almost devoid of large game animals. This domain of the Shoshones and Arapahos includes wide expanses of plain and grassland, of mountain and forest dotted with alpine lakes, the whole watered by many fine trout streams. Originally it was the habitat of the buffalo, elk, bighorn sheep, antelope, mule deer, moose, mountain lion, wolves, coyotes, and bear; of sage hen, prairie chickens, and migratory waterfowl; of rabbits and all the lesser life characteristic of the Rocky Mountains. Today the Wind River Reservation is almost devoid of big game. The mountain streams still are full of fish, but the higher elevations, except for domestic sheep, are comparatively lifeless. The occasional deer or elk which drifts in from the surrounding areas where game still is abundant, is shot down on arrival regardless of season, sex, condition, or the ability of the hunter to utilize his kill. I heard of an Indian there who recently cornered and killed four does and three fawns in July, in a place where he could not possibly utilize the meat, at a time of the year when packing it out was equally out of the question. That kill was for the joy of the kill, sheer wantonness. These same Shoshone and Arapaho Indians, having denuded their own reservation of large game, have the privilege of taking out a state license and going north a few miles where game has been protected; there they may kill their elk and deer as do the white hunters.

Sportsmen generally, and you in particular upon whom devolves the duty of enforcing laws designed to conserve a proper balance among the wild population, feel that this is an intolerable situation which cries to heaven. Indians are American citizens: why, you ask, should not the duties of citizenship go with the right? The situation is intolerable. Like a lot of other situations, it is not to be understood except in historical perspective. If we would do something effective to remedy it, we first must understand clearly how the present intolerable situation arose.

I do not believe I am maligning primitive folk when I suggest that a basic primitive trait is joy in the kill. The statement frequently is made that the Indian, in the days before the coming of the white man, did not slaughter more than he needed for food. I have observed

primitive people in the Philippines, in Brazil and in Alaska. I think a truer statement is that then, as now, primitive man probably slaughtered all he could. That he made no serious inroads in the wealth of game inhabiting North America was due to the smallness of the Indian population and to the ineffectiveness of his weapons. Three summers ago I was on Nunivak Island in Bering Sea, where the Eskimos still kill ducks and geese on the wing with a beautiful tri-pointed spear thrown by hand. Migratory waterfowl are in no danger of extinction from Eskimo spear throwers, any more than the buffalo were in danger of extinction by men on foot armed with the bow and arrow.

To primitives whose life depended upon the kill and whose chief delight was in the kill, the white man brought the horse and the repeating rifle. An Indian astride a horse with a Winchester in his hand was a potent ally of the white men who began to melt down the buffalo herds ahead of the advancing fringe of the frontier.

But also, under provocation, the Indian astride the white man's horse and armed with the white man's rifle, was a menace to the white man engaged in the process of appropriating his land or crossing the Indian's hunting grounds. Two alternatives were open: the advancing frontiersmen either could mingle with the Indian population and absorb what they did not kill; or they could shove him aside, out of the way of the line of march, and segregate the Indian on a reservation. The latter policy prevailed, to the ultimate sorrow of all concerned, I am afraid.

In this matter of game management, we today are paying for the concepts of the early nineteenth century. The Indian's title to the land always was recognized as a valid title which had to be extinguished by legal process. The Indian tribe was regarded and treated as a sovereign political entity. The process was the negotiation of a treaty between the United States and the Indian tribe, whereby, generally, the tribe relinquished its title to a broad, indefinite area in exchange for a reservation definitely bounded and usually of sufficiently princely dimensions, if not always very good land.

In these early treaties with the Indians it seemed but the merest gesture of common decency to specify that within the Indian reservation thus set aside, the Indian could hunt, trap and fish at any time of the year without restriction. Throughout the whole of the Great Plains as far north as the Arctic, bison and caribou were the Indian's staple foods; on the Pacific coast from San Francisco to Alaska, salmon was the staff of life; and in the eastern corn area as well as in the case of comparatively intensive agriculture in the southwest, much dependence for necessary food was placed upon the hunt. No one, white or Indian, could foresee the day when game might grow scarce; American resources seemed inexhaustible. It was an act of generosity which cost the giver nothing. So freedom to hunt and fish without restriction at all times of the year on Indian reservations became the law of the land embodied in federal treaties which the United States is still bound to respect.

Where primitive life and so-called civilization impinge, no social force is greater than the example of the dominant group. Written law meant little to the Indian; the example of the white man he saw invad-

ing his old hunting grounds meant a great deal. What did the Indian see?

The Indian saw white hunters slaughter buffalo by the tens of thousands, strip off the hides, and leave the carcasses rotting on the plain. At a later day, the Indian saw white hunters slaughter herds of elk and take nothing but a couple of teeth to rattle around on the rotund abdomens of a fraternal organization. The Indian saw the man who was setting the pace develop the cannon gun of the duck poacher, the automatic shotgun. The Eskimo, who at the hazard of his life, went to sea in a kayak and threw a spear into an occasional whale, saw the development of a ship with a fleet of gasoline motor-boats swinging from the davits, each mounting a gun throwing a bomb effective at long range, a floating factory capable of bringing in 18,000 barrels of oil in a single season.

The example of the white man throughout the whole nineteenth century and well into the twentieth was the example of unrestricted slaughter of game and fish. Every circumstance in the Indian's life, his descent from primitive hunters, his poverty, his love of the chase, impelled him to follow that example with vengeance and a zest. So in your criticism of the Indian's continuing destructiveness, please do not forget how recent has been the white man's conversion to a philosophy of game conservation and management.

In attacking the question of policy for game management in the Indian country, the Indian Service necessarily must differentiate between those Indian groups who still depend on fish and game for a large part of their living, and those to whom game has ceased to be of economic importance. In the first group are the Eskimos and Alaska Indians, the Seminoles of the Florida Everglades, the trappers in the delta of the Mississippi, and those Indians on the Pacific Coast who still largely depend on the salmon catch. On the great majority of reservations in the eleven western states covered by this conference, game has ceased to be of much economic importance.

You game commissioners of these western states can see clearly how the Indian has cut the ground from under his own feet in destroying what formerly was a great economic asset. On a reservation like Wind River, the mountains could be fully stocked with game without interfering with the sheep and cattle industry, and that game would go a long way toward supplying the Shoshone's larder with elk steaks and venison through the long winter. The problem is how to make the Indians see that their own interest lies in the direction of restocking, game management, and a reasonable balance between production and consumption once the reservations have been restocked. It is primarily a big game problem; fish and fowl have not suffered at the Indian's hands to any comparable extent.

The first suggestion which naturally would occur to a group whose duty includes enforcement of state laws aimed at a rational use of our wild resources, is to make the state game laws apply to those reservations within the state.

As a matter of law, that can not be done without the sanction of Congress. There will come a day when the Indian problem will be officially liquidated, treaties terminated, and Indian citizenship divested of all special rights and privileges. It will come at different

times in different states. In California, for instance, that day is fast approaching; in New Mexico and Arizona it will be long deferred. But until the United States lets go of its guardianship of the Indian, it is doubtful if the Congress will listen sympathetically to mandatory extension of state game laws to Indian reservations. This hunting and fishing privilege is one of the rights of which the Indian is most jealous; it is the point at which most sympathy can be brewed in women's clubs and sewing circles.

Is the situation, then, hopeless?

As Mr. Marshall pointed out in a recent discussion of this problem, there are two fundamental items in Commissioner Collier's policy which work in the direction we all want to go. The first is recognition of the primary importance of economic independence for an Indian standing squarely on his own feet. Concretely, the present administration has ended the allotment system, has stopped the loss of Indian lands, and begun consolidating his remaining land holdings in workable economic units; the present administration for the first time has provided loanable capital so that the Indian can develop his resources to the full; and the whole philosophy of spoon-feeding able-bodied men has been discarded as an insult to the Indian. If we succeed in making the Indian into a reasonably prosperous cattleman, lumberman, or farmer—and this is the definite goal—one great impulse leading to destruction of game, stark hunger, will disappear.

A second item of fundamental policy of the present administration is progressive self-government for Indians organized under the Indian Reorganization Act. The history of Indian administration during a hundred and fifty years has been such that the natural reaction of any spirited Indian toward any prohibition handed out by the group which reduced him to the position of a reservation Indian was to nullify and break that prohibition. Those of us who are close enough to the Indian of today to know what he is thinking are keenly aware of an intelligence which easily can be led where it never could be driven.

Robert Yellowtail, a Crow Indian, has been appointed superintendent of the Crows in Montana by Commissioner Collier. The Indians under his leadership voluntarily have declared a three-year ban on hunting of all kinds on their reservation; and some 214 buffalo and 270 elk from the surplus of the Yellowstone herds have been put on the reservation to begin restocking with these two species.

Here is the fertile lead for us to follow as practical administrators. Not, at first, compulsory enforcement of state game laws; but education, systematic and continuous, aimed at persuading the organized Indians to impose restrictions in their own interest.

In his absence, I am ready freely to confess for the Commissioner of Indian Affairs that the Indian Service has not made the slightest beginning at a systematic attack on this vital problem. The way to begin, in my opinion, is to create a new position in the Indian Service to be filled by a trained specialist in game management. His first job would be ceaseless education of the Indian, by personal contact, by speech and by written word, to the end that the Indian be persuaded to see that his interest lies in game conservation. His second job would be to act as liaison officer contacting all the forces of state

enforcement, sportsmen's clubs, conservationists, bringing them all into his organized campaign of education. When a stranger from Washington tells a western Indian something, the Indian naturally reacts against it; too often in the past he has been fooled, swindled, and cheated by men posing as his friends. But when Tom Jones, the local hardware merchant, and Dick Harper, the druggist whom he sees every time he goes to town, drive out to the reservation and have a talk with the Indians about restocking the reservation with game, the Indian listens and is inclined to learn.

In conclusion, I see no likelihood as a practical political measure, of persuading Congress to extend state game laws to Indian reservations in these eleven western states, say within the next ten years, except in California. I see great possibilities in an organized educational campaign directed by a specialist trained in game management, looking toward voluntary restriction and regulation of hunting and fishing. Given any measure of success in the creation of a sentiment among Indians for conservation of their own game resources, there will be no difficulty in securing from Congress the funds necessary to insure restoration and restocking. The money involved would be small.

If you gentlemen concur in this suggestion that the way to begin is to appoint a trained man to head up a new fish and game division in the Indian Service, probably as a branch of the Indian Forest Service, may I suggest that a recommendation to that effect addressed to the Secretary of the Interior by the Western Association of Fish and Game Commissioners would have more likelihood of favorable consideration than an appeal from any other group in America?

Discussion Led by S. L. Lewis, Arizona

BARKER: I am sure we appreciate this very instructive and enlightening paper Mr. Nash read. It's one of the best I ever heard at our conferences and I want to say also it is the frankest statement of facts I ever heard come from a federal official. We should be able to work out a program of some sort.

LEWIS: When I looked into this thing I found out that the state game departments did not have any authority on Indian reservations. Mr. Nash has cut my discussion short as he has admitted everything I intended to accuse him of.

Down in Arizona and in several other western states, but in Arizona particularly, we have between 19 and 20 million acres of ground in Indian reservations. I am glad to say on some of these reservations we still have a reasonable supply of big game. One is the Apache Reservation located in the central part of the state. There are some places in Arizona where if regulations were put into effect and carried out in some manner, and I think that they can be accomplished and work in cooperation with the Indian Service and the various superintendents of those reservations, a lot of big game administration can be taken care of. Game can be restored where there is enough stock on those reservations for propagating purposes. If we go on another 10 years, or possibly longer, as Mr. Nash says, before any definite action is taken there probably will not be any big game animals left to speak of. We hear a lot of criticism in Arizona in

reference to the hunting and fishing on Indian reservations. Some charges are possibly true and some may not be, but here are some of the things that come up among sportsmen occasionally and this seems to be that possibly some white employee on an Indian reservation invites his friends in from time to time to hunt on that reservation, obtains special permits, possibly from the superintendent of the reservation, and thus it is causing a lot of dissatisfaction in Arizona. There has not been a good feeling among the sportsmen towards some of the Indian superintendents of the various reservations because there is no question there but that they have absolute power as far as any hunting or fishing regulations are concerned on those various reservations.

On the Apache Reservation there are some of our best trout streams. For a number of years, for a period of at least 10 years, those streams have been stocked with fish by the state game department. Some of the sportsmen think this is unfair. A fee of $3 is charged by Indians for a season permit to fish on the Apache Reservation added to the state game license of $1.75. The annual reservation permit is $1.25 more for a season than our state game license, and we supply all the fish. That sounds more unreasonable than it actually is. The superintendent I think goes further towards game consideration and game management, that is with reference to the law enforcement, than any reservation in the State of Arizona. Out of that fee he keeps men in the field during the fishing season and patrols there and the sportsmen who buy the permit and go there to fish are very well regulated and must live up to the state law with reference to season and bag limit. The Indian, what they do out of season and with reference to our state game laws, of course, we do not know because we go on that reservation only at the invitation of Mr. Donner.

A bill, passed some two years ago of which I have a copy here for comment, is known as the Coordination Bill and it merely states that the various federal departments should work with the Indian Service in the development of some plan of game conservation and propagation on the various Indian reservations. The information I can get from Mr. Nash is that, and he answered it very plainly, there has been nothing accomplished or very little effort has been made to accomplish anything towards regulating the Indians on the reservations. To be frank with you here, I don't know unless this group of men interested in game conservation would follow along Mr. Nash's suggested outline that we pass a resolution requesting the Indian Service to try and work out some plan towards regulation of wildlife on all Indian reservations out here in our western states.

I was going to discuss here some of the things that Mr. Nash answered, but as frank as he has been I don't know of anything that we could accuse him of that has not happened on the Indian reservation besides what he has admitted.

NASH: The Indian enjoys special privileges on his reservation, but it was not contemplated that the Indian Service shall ever extend special privileges on the reservation to others. If that is brought to the attention of Commissioner Collier he will act, and if there is any state law by which the commission can prosecute then you can do so. In reference to stocking reservations by local groups and then the Indian charging a fee for fishing and hunting on his reservation, the

Indian undoubtedly has a right to utilize his reservation any way he can and to make all the money he can out of it. We are up against the same problem on the Tule River, stocked by the sportsmen's clubs. The Indians did not charge any fee there and then came a time when they wanted to make some money and gave them two years' warning. After two years we are going to charge $1 a day and they stocked the streams. Now the federal government is responsible for stocking the streams and letting the Indian charge.

MACAULEY: The land on the Indian reservations is considered as within the state in which they belong and the state laws on the reservation would apply to whites as well as when off it.

NASH: Yes.

MACAULEY: Then Mr. Lewis could enforce the law on the reservation as well as off. In regard to reservations in Washington, we have several, most of the lands belong to the whites.

AIKEN: Would the state law be enforced on the Indian reservation regarding violations? In other words, the Indian can take fish by any means he sees fit at any time of the year but he can not go off and sell them out of season.

LEWIS: What right would a patrol deputy have in any state on a closed Indian reservation? What authority would he have over a white man employed by the Indian Service shooting game out of season on that reservation?

NASH: I am not a lawyer, but my opinion is he would have full rights to go in and arrest him. Washington has done it and is doing it regularly. Last week we arrested some and they paid fines.

PROGRESS OF THE GENERAL WILDLIFE FEDERATION

By Jay N. Darling, Acting President, Wildlife Federation

President Barker, I didn't come here to make a speech, I came for the ride. Barker, I was surprised at the extreme mystified expression on your face when you saw me. You said those Washington fellows lied so much, I did not believe you would come, you in particular. You can't believe anything those Washington fellows tell. Well, when I left the Biological Survey I resigned all my responsibilities to that little fellow, Ira Gabrielson, and I want to speak as just one of the American citizens with no strings on me whatsoever, and I want to speak on the general topics which interest us and some of the past experiences which bear on our future conduct.

Perhaps the best way to illustrate and make you understand the origin of the federation idea is to go through the experience which I went through in my first year or two with the Biological Survey. I arrived early in 1934 in Washington. With all the millions of dollars and the millions of men which had been offered to the public to put to work for the benefit of everything—conservation got none. In the first year even, the C. C. C. camps probably cut away more environ-

ment suitable for wildlife, caused more erosion or induced more erosion by their activities than they could repair in the next five years.

As we sought to get money from the emergency funds, we found that organized background got money without much effort. Wildlife got none. Projects proposing to cooperate with the states in restoration of upland game and migratory waterfowl received sympathy but no funds. Mosquitoes, malaria control in states where they had no malaria and no mosquitoes to bite, in some regions got $116,000,000. Conservationists got none.

I am not reflecting on anyone excepting the conservationists. They had no plan; they had no organization; they had no power to back up a request for any project. In spite of the fact that there were between seven and eight million people paying license fees in this country for the privilege of hunting and fishing there was no one to back up a request for any wildlife project. Rather startling!

Little Joe Huntington of More Game Birds Foundation was the one person who woke up to the fact we were entitled to something. He went down with a proposal we make a national survey and set up a national program. Out of that grew the Beck Committee who worked harder than anyone I know. It was an exeellent program. It took up all of the upland interests in migratory waterfowl for permanent refuges. It was a good program, not detailed, but it had the essence of something we never had in this country. It never got one thin dime to carry it out. Why? Because little groups who had a project to drain a county in northern Michigan to grow more onions and mint, when already the market was bogged down by mint and onions, put in great steam shovels and drained the area in spite of our protest. That is not from the desire of any president, governor or senator to do that. It is because men in a democracy listen to the people who are vocal and produce votes.

The final disillusionment of people who should be interested in it was in an effort to get a certain sum of money for wildlife from the munition makers. All the munition makers agreed to it. I put it to the President. He thought it was a great idea and said that he would have to ask the Treasurer of the United States about this—what effect it would have on finanees. I wish you could have seen the memorandum I got back. It said wildlife conservation must receive its funds through Congress and until the public speaks through Congress, this is not to be considered. That was a definite instruction so far as official action was concerned—that it must come from the voice of the people.

I have related only a few of the steps. We could get nothing. A little starved bureau, without funds, and with all the money being allocated, we could get nothing. If it hadn't been for the much abused Rex Tugwell, the money would never have been allotted, we had to suck it out of someone's fund.

I have been a state commissioner. The same thing is true in a state. If anybody wants to build a factory and dump waste into the best trout stream of the state, try to stop it. There are between seven and eight million people who have gone on record in this country, by buying licenses, that they would like to hunt and fish. That is enough to control a presidential election.

There are 7000 groups and organizations among whose first and primary efforts is conservation in their by-laws and their constitution,

and no two of these organizations speak to each other. I don't need to tell you, the state commissioners, that you are having the same trouble I had and that Mr. Gabrielson had and we all will have forever unless we do as other interested groups do—enter into some coordinated program. I don't care what kind of a federation you have in your state. I have no desire to dictate to you, but I am telling you what you have to cure.

You don't need to charge people very much to make them talk to each other. I can't see why the turmoil within states still exists on a simple proposition as getting support in back of your own program. It makes me think of the old story of the late King George when he had an attack of the flu and got very low and needed a blood transfusion. They brought in a big, red-headed Irishman whose blood count fitted the king's. They shot the blood of the Irishman into the king and after lying a few minutes, he raised himself and opened his eyes and said, "To hell with the king." I sometimes think that is what is the matter with the conservation groups. We all really belong in some sort of an organization where we may bring pressure to bear.

I don't know how it is in your states, but in mine it takes three or four fellows to go up to the state legislature to lobby for anything we wish. Nine times out of ten, we are licked. We took a census in the State of Iowa a little while ago on what people wanted to do most. Number 2 was fishing. Number 11 was playing golf.

We are just not good business men, if we let things continue as they are. With that need in mind, we called a conference in Washington. We invited everybody—sportsmen, women's clubs, farmers, 4-H clubs, Indian Park Service and all. They came 2000 strong and feeling the necessity of this thing, they voted unanimously for it and went home to form federations within their states and out of the state federations we hoped we might form a national federation which might accomplish what we want. I was interested to see what happened after the enthusiasm sort of died down. I watched it carefully, knowing that if you can not generate some motivation in your home communities, you can not have it nationally. It has been mighty slow brewing. You know the old story of the geese cackling out on the wall that saved the town. It wasn't really the geese cackling on the wall which saved Rome, but the fact that the geese woke up the Roman legions who saved the town. If they had turned over and gone to sleep when they heard the geese cackling, Rome wouldn't have been saved. Wildlife won't be saved if you stop with your meetings. Organization by you back home has to be carried out. I would say the number of states which are really active is probably 14. We have 24 which claim to be active, but upon investigation we find they are poorly organized and won't work.

We have 14 and Mr. Grebe of Idaho has done the best job of anybody in the United States. He ought to have a medal. I know California is in some distress over the conflicting agencies—whether this group or that group is going to run it, and what is going to be their policy. The main object of the federation is not to have arguments between groups, but to accomplish the main factors and have adequate financing, under state management for the formation of a wildlife program. There is no policy in the national government

the same as in the Indian Service. There is no policy for wildlife restoration and never has been. We have made plans, but nobody ever adopted them. There should be, and if you pardon me for taking your time, this problem of state and federal responsibilities isn't such a difficult thing.

The federal government should be bound to see that no species becomes extinct. No one else can do it. I believe that the federal government has a definite responsibility to see that no species is exhausted completely. That is number 1. Out of all this land, which is under the jurisdiction of the American government, certainly there is enough to provide a home for each one of the major species, and enough to keep them alive. That is number 1 of the federal responsibility.

Migratory waterfowl is number 2. It is in the same category. The states couldn't do it. The federal government must do it. When you get beyond that you have the state's responsibility which is for all upland game.

Barker used to row with me about the Taylor Grazing Act, although we had nothing to row about. We insisted on something being preserved for game. Barker has done it in New Mexico. He went in and grabbed it before it all went.

The states have a responsibility for upland game and between the two, the federal and the state, we have a joint responsibility which is greater than all the rest of them. Some such program as the following should be developed: The federal government shall establish a fund similar, if you like, to the national highway fund, which shall be contributed to the states in cooperation with state activity. You remember the old days when we built roads by county supervisors and township trustees. They built a road this year with taxes and the next year they had to rebuild it. Culverts were made of wood and there was no permanent road system until the federal government set up a cooperative fund and said that we must have some sense in this. Out of that has grown our federal highway program. The federal government takes its share and the state government its share. It is done under an engineering plan. No attempt is made to dictate. The same thing could be done for wildlife. I am satisfied that no congressman would turn down a bill to provide for cooperation between the government and his state. Maybe I am wrong. I know if you had an organization and would write to your congressman, you would probably get it. That is the genesis and anaylsis of the Federation.

I have been very careful not to go into any state to say that the Federation is no good just because I used to be in Washington, and Barker and some others are suspicious that I am trying to dictate. You have to do it yourself and at home.

In November, after election, I hope to call, as acting president of a tentative federation, a national meeting of the states which have organized and have them form a permanent organization so that when the next session of Congress meets we will have a mailing list. At least we can tell where to start. We will be a little volunteer fire department if you wish to call it that, and will come to the rescue of national and state crises.

Among the early things which came to my attention in the bureau, I had a great many excellent technicians in the Biological Survey who

are eating out their hearts to do something and as far as they could they did and would write up their findings, but would get no place. We all need them.

I conceived the idea that the state agriculture departments might use them, and the state fish and game commissions might combine on the use of a technician. We prepared a bill for Congress and put it in a general agriculture bill that we be allowed to pay $6,000 for a technician in California, say, or in any other state.

The Secretary of Agriculture said it was fine. The budget director cut it out. We had to sell it to the budget director and we explained the whole situation to him and he said he would put it back in. At Congress, they cut it out as something new. We had to go to work on each individual down there, through the names of congressmen who might be on the committee who had that bill in charge—all to no effect. During the general hearing, a door opened and in walked a man whom I had never seen before and asked for cooperation between the Federal Biological Survey and the states on game management. They explained that they had cut it out of the bill. He said that Alabama would like to have that section in. They said, "Oh, all right," and rubbed out their blue pencil delete marks.

I later discovered that it was Congressman Oliver, who knows very little about wildlife, although he is interested, and I asked him how he happened to do that. He went back to his desk and showed me a letter which apparently required some effort to write from someone interested, and he said in the most simple language that Alabama needed somebody who knew something about game. One letter to the congressman got action. If one fellow can get something done, how about trying to enlist some share of the seven or eight million people who are paying for licenses, and some share of the women's clubs and garden clubs, and the landowners more interested in conservation?

I started out altogether on game and wildlife conservation. I have now become a convert that this is not just wildlife, it is bread and butter to all future generations. When I read that eight and nine hundred million acres of tillable land on this continent are now retired out of use and 26,000,000 annually approach the unproductive state, and our population is increasing gradually, I can not contemplate more abundant living when the ice box and the pantry have less and less in them. No matter whether you have dictatorship, or what you have, if you can not have the natural resources producing for you, you are poverty stricken and you will starve.

Look at your water systems from the Atlantic to the Pacific. I can remember when there was an Atlantic run of salmon; now they are gone and most of the shad are gone and your sturgeon run up the Hudson River is gone. The Mississippi River is inert as a glass of water with nothing in it. Sturgeon are gone out of it. The game fish which used to spawn in those long stretches of limestone and rapids which feed the country where the Mississippi permeated, are all gone. The herring run is gone. The upland lakes from Montana to the Finger Lakes of New York are dying from lack of care and attention. Come over on your Pacific Coast and see where the salmon are going—where are your commercial fishers taking their catch? Down below

the Mexican borders, and why? —because you have exhausted your own.

I am not talking about the man who wants to cast and will go looking for a good stream; I am talking about something more fundamental. When they talk about the ecology of waters and what produces the fish, very few know about it.

I came here for a nice visit. I enlisted for the duration of the war, but I don't want anyone to fight me, but I want to fight with you fellows for the same thing you want. I think I know most of your problems.

Discussion

COOK: How many of us are federated?

DARLING: I can't tell who are here. Idaho, Nevada, Wyoming and Montana. Oregon has a federation. California has no federation. It claims to have, but it has none. I don't know whom to turn to. I don't want to tell anybody they have to federate with the other states. Cook said a while ago they tried to federate but the cattlemen took it away from them. I know how it is—in one state the women's club stole the sportsmen's show. I don't care if I only have somebody to write to who can write to their congressmen—some contact with you folks. Somebody to come to when the fire bell rings. I hope you will contact your state junior chamber of commerce, I don't care what kind of a federation it is.

COOK: We have a sportsmen's federation in Utah so strong in our State Legislature that it has knocked the ears of everybody down until we tried to start a cooperative plan.

PENDING AND PROSPECTIVE WILDLIFE LEGISLATION

By Carl D. Shoemaker, Secretary, Senate Wildlife Committee

There is one thing, a misstatement that Mr. Darling made, and I always like to check him because he is checking on what I say. He said that the water in the Mississippi, if you held it up in a glass, would have nothing in it. He has forgotten, because there is nothing but mud, filth and pollution in it. It's filled with it and that's the reason you have no fish there.

It's always a good thing to follow a dynamic speaker like Mr. Darling. I am going to briefly outline some of the things that happened in the last year and some of the things that are going to be proposed in the coming session of Congress.

The last session of Congress was not productive of a great deal of wildlife legislation. Three items stand out possibly in some prominence. One is the ratification of the treaty with Mexico, similar to the waterfowl treaty with Canada. Second is the sock-eye treaty negotiated and ratified with Canada so far as sock-eye salmon are concerned in Puget Sound and the Fraser River. Nothing has been done with that and won't be until they get a commission appointed in both countries to handle the situation. The third was made by the Biological Survey

and other organizations in increasing the appropriation of the Biological Survey. It was a pretty tough proposition to get more money out of Congress for direct appropriation. It's easy enough to get large millions and billions for this and that, but to take $100,000 for this or $40,000 for Alaska is difficult. After a long struggle, having been kicked out in the House, the Senate was able to make a number of appropriations to increase the Biological Survey appropriation this last year by about $175,000 more than received before, which, of course, will go into the budget next year and remain there and from that we will again try to get some increases. There were some other things which I need not go into.

Before I talk about what may happen in the future, I want to go back to the grazing act and the Indian situation. The great difficulty as I see it is that Congress passes a bill, it has certain ideas in its mind when it passes that legislation, and then when the bureau or agency which administers that law puts it into effect and comes to working it out, it has an entirely different conception of the situation. That is true of the Taylor Grazing Act. I attended the hearings of the Taylor Grazing Bill. I know what was in the mind of the people who appeared there before that committee. I know what was in the minds of some of the members of the committee itself when the bill was reported out. Certainly wildlife was to be recognized. Certainly it was to have its day in court. The administration has not been as sympathetically inclined with the wildlife as it was intended by Congress when it passed that bill. That's the only comment I will make on that bill.

On the Indian Service, the coordination bill was passed in 1934. There was a definite mandate on the part of Congress to the Indian Service, the Bureau of Fisheries, and Biological Survey to work out a plan with reference to wildlife so far as the Indian Service was concerned. Nothing has been done, as Mr. Nash said.

There were a number of bills in Congress last session which had to do with wildlife which did not pass or died with the session.

Number 1 would probably be the bill introduced by Senator Lewis, similar to the one to change the name of Arkan'sas to Ark-an-saw. I see you have heard that story. This was to change the name of the Department of the Interior to the Department of Conservation. After a long and bitter struggle, lasting over two sessions of Congress, the bill finally passed the Senate, and died in the House.

On the other side of the capitol was the Kleberg bill in the House which proposed to consolidate certain conservation activities. It didn't get very far. It became known, I think, around the halls of Congress that the Kleberg bill was nothing more or less than a stop proposition for the Lewis bill in the Senate and therefore it didn't get very far.

Another bill which was introduced and over which there has been some bitter fighting was the antipollution bill. There was a bitter struggle to see who would obtain the dominance. Nothing was done. Yet this pollution problem is probably in the category of one, two and three so far as wildlife is concerned. Next session of Congress another effort will be made. I don't believe any of the bills will be reintroduced as written then, for the simple reason many angles have developed which will of necessity have to be ironed out. The smallest angle in the

whole thing is the fear on the part of the state health departments that they will be frozen out in the solution of this problem.

Those are the important conservation matters which died with Congress.

What is in prospect? I am going to leave the most important to the last. What is working now in the matter of consolidation or better coordination of federal wildlife agencies? There is a great deal of thought being expended at the present time. Last session, Senator Byrd introduced a resolution to examine into the bureaus of the government to see if it was possible to consolidate some of the numerous agencies we have; to see whether or not some of this waste could be done away with. Senator Byrd is an enthusiastic believer in wildlife restoration. He is a member of the senate committee on wildlife and a student of governmental affairs. He has assured me that he expects to devote a considerable portion of the hearings of his committee to a study of the problem involved in coordination of governmental wildlife activities.

You know what we have. We have them scattered all over the government. We have the Bureau of Biological Survey and Forest Service in the Department of Agriculture; Bureau of Fisheries in Commerce; Park Service, Reclamation and Grazing in Interior. No one knows now, and no one yet has a plan which will properly consolidate all of these agencies. It seems as though an actual consolidation of all of them is impossible.

There has been some thought that possibly a new federal department should be created with a Secretary of Conservation. This does not seem to answer. It may be that some plan for real coordination of these federal wildlife activities will be developed. In any event I think some progress will be made at the next session of Congress on this very important and vital problem.

I already mentioned the pollution proposition which is again going to pop up. Involved in this are many other problems. Flood control, erosion, reforestation and a number of others all enter into this particular problem. Those are some of the angles which will have to be ironed out before any suitable bill will get a real hearing and get through Congress.

Another matter and the last one, I want to talk about is the one Mr. Darling mentioned and that is a federal aid program for wildlife restoration in the states. Mr. Darling did not know I was going to talk about this matter. As a matter of fact the chairman switched the deck on me, I was supposed to talk about the federation and I did not know I was to talk about legislation. I came carefully prepared to talk about the federation; had a speech all written out and committed to memory. Mr. Darling got hold of it and he gave the speech I was supposed to give today, and a cold deck was given me this morning on legislation, so you will pardon me if I repeat a portion of what Mr. Darling had to say about the federal aid program.

I think it is one of the things behind which the General Wildlife Federation can get with a certainty and that some action will be taken by Congress. It is not impossible to get a program of that kind with one session of Congress. It may take two sessions or two years before such a program can go across, but it is worth while.

I sent out some time ago to every state game commissioner, a feeler. I wanted to find out how the state game commissions would react to such a proposal. Remarkable as it may seem, from the source I expected to get the most opposition, I received the greatest strength and that is right out here in the eleven western states. My good friend Newell Cook surprised me above all things when he wrote to me and said he was wholeheartedly behind such a program, and I take my hat off to you for those kind words, Mr. Cook.

Barker said it was a thing we ought to discuss and I hope you will bring it up at the Western Association meeting. So on down the line the states generally, some feeling their way a little bit, not knowing what was in contemplation, but all realizing that money was the necessary, essential thing to bring about more quickly a wildlife restoration program, realizing it wasn't within their own power to put across, and they thought the plan had great possibilities. I turned over the correspondence to Mr. Darling.

Surely on this plan where we propose a federal aid to a wildlife restoration program with the states along the lines that have developed our great highway system. (And by the way I want to digress for one moment. I think Mr. Burns misinterpreted my letter in which he thought we planned to increase the gasoline tax in order to take care of this federal aid program. That was used as an example.) It will be easy to put over a program of this kind with a wildlife federation backing it; with the state fish and game commissions backing it; the general federation getting women's clubs, farmers' organizations, civic organizations, rod and gun clubs poking at their congressmen and senators, not when they are back in Washington. Don't make the mistake of waiting until your congressman gets back to Washington; this is the mistake they make by waiting. Take your congressman out fishing and tell him the story. Go and see him right here. Put your program over when he is back home in close contact with you. There is no question about that. Aiken, you are agreeing with me.

AIKEN: Especially election year.

SHOEMAKER: The details of this program will have to be worked out along the lines of a bill which will pass Congress. It will be modeled in some respects after the federal road bill, which is a good bill, and made it possible to ruin most of the wildlife in the country, but nevertheless no one would want to go back to the old highways, so there will be no invasion of states' rights or control over its wildlife, but there certainly will have to be some adherence to a standard of wildlife restoration and care and management, and I think anybody who is fair will agree that will have to be done.

Now, how can this federation Mr. Darling was talking about, help in this situation or in any legislation?—simply through the channels of contacting the congressmen and senators in the manner he outlined. We can't hope to bring about any program of restoration. Gabrielson has worked out a fine national program. You expounded it at the North American Wildlife Conference in Washington. That's the basis of your program right there, yet none of those can go unless you and you and all the rest of you take enough interest in it to see that your state is properly organized along the lines of the General Wildlife Federation. You can have that organization in almost any way you

want it as long as you get the people in it interested enough to help out on your state and federal program.

These are the three particular things that are moving—first the Byrd Committee, which is going to look into the matter of consolidation or better coordination.

Second, the antipollution legislation, pure water and better streams, and

Third, the federal aid for a nation-wide state by state wildlife restoration program.

There may be, of course, other things that will bob up from time to time—amendments to bills passed in previous sessions. After you pass a bill it may have to be changed simply because administration of it brought out these angles that needed correction. This will be the broad scale development in the next Congress.

Thank you.

WHAT THE OREGON GAME FARMS ARE DOING

By 'GENE M. SIMPSON, Superintendent of Game Farms, Oregon

In President Barker's telegram requesting this paper he asks that I "just tell what the Oregon Game Farms are doing this year." In a general way I can answer that question by simply saying that we are confining ourselves to the production of pheasants and operating to capacity. As a matter of fact our inventory of birds indicates that we are operating beyond capacity.

The largest number of pheasants ever produced on the Oregon Game Farms in one year was last season's production of between thirty-two and thirty-three thousand birds. At this writing, July 17, we have hatched 19,465 young pheasants at the eastern Oregon game farm near Pendleton, and 31,912 at the game farm near Eugene, or a total of 51,387 young pheasants. In addition to the birds already hatched we have upwards of 13,767 pheasant eggs under incubation from which we can probably count on raising at least 5000 pheasants more. We do not use eggs after about the tenth of July since our experience has been that the later eggs do not hatch as well or produce as good a bird as the earlier eggs.

In anticipation of an increased production the pen capacity of the eastern Oregon farm was at the beginning of the season increased to accommodate 6500 more birds. A new holding pen to be used for artificially brooded birds was constructed at the Corvallis farm with a capacity of 6500 birds. These additions have proven inadequate and we are now further increasing our holding capacity by fencing in three five-acre tracts, one at each of the game farms, in which we intend to hold 6000 additional pheasants under brail.

Until last year the Game Commission was not particularly concerned about the total capacity of its holding pens because it was the practice, after the holding pens were filled to release the young pheasants as soon as they were able to take care of themselves in the field, usually at the age of about ten weeks. The present policy is to hold as many birds as possible until after the close of the open season, upon the theory that when birds are released before the shooting season there

is a strong probability of their being killed within a few weeks, whereas a hen pheasant released after the closed season has an excellent chance to survive until the following season with the probability of raising as many as ten young, thus very greatly increasing in numbers the effectiveness of the game farm production.

Heretofore our birds have been held in wire covered holding pens at the game farms and in similar pens in different counties, the latter being provided by the sportsmen of these localities. For these sportsmen's pens the Game Commission furnishes the feed for the birds and the sportsmen provide someone to look after the birds and do the feeding. These birds are released as directed by the sportsmen themselves.

The purpose of the holding pen was to relieve congestion at the game farms and provide a means of holding birds until maturity and particularly to hold them until after the hunting season. We consider holding pens at different points in the state as valuable adjuncts to the game farm production, and something to be encouraged.

The fact that we had birds beyond the capacity of all our pens and that the construction of wire covered pens is expensive suggested the advisability of holding birds under brail thus permitting them to be confined in uncovered pens. The pens for brailed birds we now have under construction will be enclosed with six-foot two-inch poultry netting with two one-foot boards next to the ground. We expect to brail the birds at twelve weeks of age and after one month's time to change the brail to the other wing lest longer keeping the brail on one wing at that age result in deformity. With us brailing at this age is more or less experimental and we hope to learn much on this subject from our experience this year.

At the eastern Oregon farm this year we have used domestic hens exclusively for hatching purposes. At the Eugene farm we have used both setting hens and electric incubators and brooders. In the use of the setting hen and care after hatching we are following with little change the methods that have been gradually developed at the Oregon farms during preceding years. The nests are arranged in sections of four nests with closed fronts and these nests are placed in wire pens to protect the hens from being disturbed. Usually about twenty-four hens are placed in one enclosure. As the eggs hatch each hen is given about twenty-five birds and removed to a larger pen, where it remains. The hen is removed when she is of no further use to the small pheasants. Ordinarily this will be when they are six weeks of age. This larger pen has been prepared in advance for the reception of the hen and pheasants by being planted to rape, clover and other appropriate crops. This system of handling the young pheasants has proven very satisfactory in the past and results in strong, healthy birds.

More recently we have also been using a combination coop and runway in which to hold a hen and brood up to the age of six weeks, that has given excellent satisfaction, and as I have not heard of anything similar having been used elsewhere, I will give a brief description. It is an all-weather all-purpose coop and runway, is cat-, hawk-, and owl-proof and has a number of outstanding advantages not found in any other similar equipment in use at this time so far as I am advised. The entire combination is four by twelve feet in size and so arranged that one end is a coop two feet by four feet and the remainder is a runway

four feet by ten feet. The coop portion only is floored and has both a wire and a board cover. It is divided in the center so that the hen is confined in a space two feet by two feet leaving a space of the same size under cover in which to place feed for the pheasant chicks but beyond the reach of the hen.

The sides of the runway are of boards nineteen inches high, and the top is of one-inch mesh netting on sliding panels. The board top of the coop portion is sloping to shed rain, is hinged on the runway side so that it may be opened to clean out and air the coop and may also be used as a shade for part of the runway.

In use the hen is at all times kept in the two feet by two feet enclosure reserved for her and during the first twenty-four hours the young pheasants are also confined in the same space. A small trap door is then opened admitting the young birds to the remaining portion of the coop. If weather conditions are unfavorable they can be held in this part a week or so but ordinarily they are given the freedom of the entire coop and runway after about the third day. By allowing the hen but half of the floored space the young pheasants have a dry space in which their feed is placed.

At the end of about ten days, the young birds are temporarily confined in the floored portion while the whole combination is then moved in any direction a sufficient distance to place the runway on new ground and provide new forage—two factors essential to the most successful care of young pheasants.

This combination coop and runway will accommodate twenty-five young pheasants up to the age of six weeks, when they will then be sufficiently advanced to take from the hen and turn into the larger pens. The combination may be built so that it is collapsible and while somewhat more compact for transportation and storage is slightly more expensive to construct.

An acre of ground will easily accommodate seventy-five of these combination coops and runways. Allowing twelve weeks in which to raise two broods to weaning age in each coop there will be room enough on an acre to permit moving all of the coops and runways onto fresh ground every ten days without using the same ground a second time the same season. A conservative estimate of the number of birds to be raised from two broods to each coop would be thirty-six birds making a safe capacity of one acre under this system 2700 birds per year.

We now have 250 of these combination coops and runways in use and I have no hesitation in saying that my experience with this combination for the past two years convinces me that it is one of the best if not the best way to handle young pheasants up to the age of six weeks.

Domestic chickens may be raised in crowded brooder houses, but never the wild pheasant. From the very day it is hatched until released the ringneck pheasant longs for its freedom; it can not be domesticated, and we do not want to domesticate it. When we do it is no longer a game bird. The movable brood coop affords the young pheasant the privilege of foraging in new territory. Even though the amount of food thus obtained may be of negligible quantity, the natural pursuit

of food is an aid to the prevention of that unnatural vice so prevalent with young birds in close confinement—cannibalism.

The advantages of the use of this piece of equipment may be enumerated as follows: (1) The entire combination is small enough that it can be stored under cover in the winter for its preservation, (2) it can be easily sprayed as a precaution against disease and parasites, (3) the cover affords protection against storms, (4) the young birds are protected against their enemies, (5) clean ground and growing feed are provided as required, (6) the location is conveniently cultivated and planted to forage crops, (7) the birds are under direct control and easily transferred to larger pens, (8) it discourages cannibalism, and (9) it is well nigh ideal when birds are to be brooded with a domestic hen.

Heretofore we have depended almost entirely on poultrymen in the territory adjacent to the game farms for our supply of setting hens. We run standing advertisements in the local papers and collect hens. At the end of the season the hens are then sold in the open market. While this method of securing hens is satisfactory in that there is usually an abundant supply to draw from, there are two disadvantages. One is that in taking hens indiscriminately from all kinds of poultry yards there is always the danger of introducing disease and parasites, and the other disadvantage is that the average dependable setting hen is a large heavy type of hen and not so well adapted to mothering young pheasants.

I have found the most satisfactory hen for brooding pheasants to be a clean legged cross between the buff Cochin bantam and Rhode Island Red. We have a considerable number of these crosses on hand and are increasing our flock and hope eventually to produce all our own setting hens. In this way we will not only have a hen more reliable as a setter and better adapted to brooding young pheasants but will be better able to avoid disease and parasites.

Recognizing that the climate of eastern Oregon with its dry, cold winters is different from the warm, rainy winters of western Oregon suggested the advisability of using different breeds of pheasants for these two sections of the State. I was informed through Mrs. Denny, whose husband while Consul General at Shanghai introduced the Chinese pheasants into Oregon, that the climate at Shanghai was very much like that of western Oregon. This doubtless accounted largely for the success of the venture in transferring these birds from the Orient to the Occident, for you will recall that the first successful attempt in naturalization of pheasants in the United States was in 1882, when fifty birds were released in the Willamette Valley in western Oregon. Mongolia is in northern China and hence it occurred to me that the Mongolian pheasant would be better adapted to eastern Oregon, and experience has verified the correctness of this theory. Our pheasant stock at the Pendleton Farm is Mongolian blood, while in western Oregon the blood of the Chinese Ringneck predominates.

Last year we produced on the Oregon Game Farms something over 5000 pheasants by artificial methods using electric incubators and electric brooders. This year we will exceed that number by a few hundred. We have been limited in our production in this manner by the extent of our equipment. Our present brooder houses and runways

are not satisfactorily designed or constructed and we are now preparing an entirely new setup for our artificial hatching and brooding. This work is being carried on at the Corvallis Game Farm and in the future this method will be exclusively practiced there.

It is the writer's experience that pheasants hatched and brooded by artificial heat have not been as vigorous and gamey as those more naturally produced by the domestic hen, but this is not saying that it can not be done or that pheasants so produced while not of the excellence of the hen-hatched and brooded birds, may nevertheless be of a quality sufficiently wild, gamey, strong and vigorous as to be acceptable for release in the wilds. The principal advantage of the artificial method as I see it lies in the better opportunity to control disease and parasites. I have not been in a position to keep data on the cost of production by the two methods to determine definitely the relative cost. I hope to have more accurate information on this subject next year.

It is generally admitted that it is not wise to keep pheasants or even domestic chickens on the same ground year after year. Most healthful conditions come from change of ground annually. This is not always practicable. Annually plowing the ground may, under circumstances, be helpful, but it does not afford absolute protection particularly as against gape worms, the eggs of which may be distributed through the ground and brought to the surface by fish worms to be eaten by the fowls.

Our new setup at the Corvallis Farm is so designed that the young pheasants are not kept on the same ground longer than four weeks in two years. We recognize that this is not entirely perfect from a poultry veterinarian's angle but it does reduce the danger to near the minimum and from a practical standpoint is conceded by the specialists at the Oregon State College as being acceptable.

This change of ground is accomplished by having the brooder houses and the brooder runways each built separately and movable. There is a separate pen for each brooder house that is 24 ft. by 24 ft. in size, built in panels bolted together that they may be knocked down if desired. There is a collapsible hinged partition of simple construction for use to reduce the size of the pen when the birds are very young, keeping them nearer the brooder house. This is removed entirely in about two weeks. The brooder houses are ten feet by twelve feet and built on skids. The pens can easily be placed on skids and in this way both can be periodically moved to new locations. By arranging the brooder houses and pens in orderly rows the ground can each year be conveniently cultivated and sown to crop for the young birds.

Our operator in charge of the artificial hatching and brooding is a young woman who before entering college had considerable experience in the artificial production of chickens. Last year she graduated in poultry husbandry at Oregon State College and in addition to her regular work is now carrying on some experimental work in methods of incubation and brooding pheasants particularly as to temperature and moisture.

Mr. Einarsen of the U. S. Biological Survey stationed at the college has this season obtained the records of the temperature during incubation in the nests of two wild pheasants and we are hoping to

get some valuable suggestions from these records. In fact one reason for devoting the Corvallis Game Farm to artificial incubation and brooding is because it is in close proximity to the State College and the poultry husbandry and biological staff there are interested in our work and we expect to derive assistance from their cooperation.

It is our intention to continue this experimental work next year as corollary to our regular production in the hope that we may increase the percentage of incubator hatch, the percentage raised in the artificial brooders and improve generally the quality of the incubator birds.

In conclusion I might mention that the Game Commission and the 4-H Club organization are cooperating in interesting 4-H Club members in pheasant breeding. Considerable interest in the subject has been shown by 4-H Club members but it was thought inadvisable to engage in the work on too extensive a scale the first year but rather to limit the number who take it up to gain experience. Under the present plan used this year the State Game Commission supplies the eggs through the county 4-H Club leaders. The Commission also provides written instructions for building nests, coops and pens, preparing feed, feeding and management generally. This is mimeographed and with blue prints of equipment supplied to the club members who have undertaken the work. The Game Commission engages to buy all acceptable birds at the age of ten weeks for 75 cents per bird. Whether or not the work will be continued another year will depend on results obtained, the demand and on the advice of the 4-H Club leaders.

The Commission this year had more pheasant eggs than it could use and therefore advertised to supply eggs free to anyone wishing to experiment in raising pheasants. As a result the Commission distributed 10,000 eggs, but it is too early yet to report on results.

Taken all in all and considering our handicaps we are fairly well satisfied with the year's work thus far. Unusual weather might raise hob with our results, but is hardly probable. I have been in the game for over thirty-five years and find that there is always something new to be learned, always room for improvement. The sportsmen of the state want birds and our object is to give them just as many as we can. We always hope to raise more and better birds next year. The Game Commission's ultimate objective is 100,000 pheasants annually.

THE SALMON INDUSTRY OF THE COLUMBIA RIVER

By WILLIAM J. FINLEY, Oregon

Each stream that rises in the mountains and flows down across the valleys to the sea has certain values as we all know. The water may be used for domestic purposes, may be used for irrigation purposes, for navigation, for the production of fish, also for recreational purposes. It seems to me one of our greatest difficulties today is in these various uses of the rivers that certain industries and certain uses destroy the other uses and that is the difficulty in regard to our salmon of the Pacific northwest.

You all know the life history of the spring chinook salmon, that it comes in the early months of the spring and ascends gradually on up to the headwaters where it spawns and dies. The little fish come back downstream and finally reach the ocean and unless this can be done it means extermination of the species.

You all know about the Bonneville Dam, 140 miles from the mouth of the Columbia—a dam about 60 to 70 feet high. The engineers have done everything possible to put the proper fishways over this dam so the runs of salmon could get on up to the headwaters. However, there has not been enough money allotted for the conservation of salmon in regard to Bonneville Dam. On the other hand some 60 million was set aside for a dam farther on at Grand Coulee, 450 miles up from the mouth. This dam is perhaps considerably larger from a standpoint of power and there should be a fish ladder. This dam will average between 400 and 450 feet in height and is to be used for irrigation and power. To put any fishway on this dam is impracticable and the only alternative that can be offered is for a hatchery to be placed at the foot of the dam. Our objection to this is that the spring run chinook reach the dam before they are near the spawning stage, and have to be held and practically kill themselves in fighting to pass over the dam. This will mean the depletion of the spring run of chinook in the upper Columbia as far as that part is concerned.

This project is settled and nothing can be done.

Further protection may be checked by the organization of business money and people in the central part of Oregon and Washington who are fighting to put more dams in the Columbia and Snake rivers which will eventually cause the utter destruction of all the salmon there. The salmon of the Columbia means about ten or twelve million dollars annually to people along the river in that vicinity. Many families get their living from the fishery. It is a 5 or 6 per cent interest on an industry valued at 200 million dollars. They are spending many millions in building dams for power and particularly for irrigation and the question arises as to whether we will ever get enough in return for the destruction of a great industry like the salmon industry in the Columbia, although it is almost impossible to fight that thing. They say you can not fight development of a state or country. I think this can be done as in California years ago. A big company wanted to put a dam in the lower Klamath, in 1924 I think. It was put up to the Fish and Game Commission and to a vote of the people, who said there should be no high dam in the lower Klamath. There are places it seems to me in the State of Oregon and along the Pacific coast where power can be developed in streams aside from the best salmon streams. Whether the Columbia can be saved is doubtful but I think we should fight to bring this matter to the attention of the people. Consider the Sacramento River in this State. It was a very fine spring salmon stream years ago. The killing of the salmon was the result of big dams and irrigation, lack of screening ditches which let little fish out into the fields to die, and the pollution of streams.

We are fighting in Oregon today to clean up Willamette River because it is the best stream as far as the early run of chinook salmon is

concerned. If we can conserve that stream and clean it up we will always have at least a few salmon going upstream.

One use of a river so often destroys the other uses and that is very difficult to correct. In southern Oregon the Rogue River is a very valuable fishing stream. Mining operations in the upper reaches have destroyed fishing until now that once valuable stream is valueless, is simply a mudhole from one end to the other and out into the ocean. You can not stop mining, but the only way to prohibit such uses of our streams is to get interested people together, and it is the same in certain other streams where lumbering and logging are carried on. The river should be used by the public in the right way, but one industry uses it one way which destroys its value from all other standpoints. It so happens that power dams for irrigation are doing more damage in Oregon from the standpoint of fish than almost any other cause and the only possible way to stop it is to try to work out something to provide for proper screening of diversions and to prevent further pollution of streams.

THE SOIL CONSERVATION SERVICE

By EUGENE D. EATON, Soil Conservation Service, U. S. Department of Agriculture

I am glad to have this opportunity to discuss our service but with as full a program as you have here. I will attempt to make my remarks as brief as possible. I know that all of you are familiar with conditions and appreciate the validity of the remarks made by Mr. Darling about the dissipation of our natural resources and the depletion of soil and plant cover. I would like to take a little different angle from the restricted remarks made this morning. I was very much impressed with Mr. Barker's and Mr. Parvin's papers, indicating that in the 15 years of the history of this organization you consistently recommend the restriction of federal activities in wildlife management, and the fact that I am here representing another bureau that considers itself engaged in wildlife management work looks as though you failed. I would like to clarify my position to indicate that you need not look askance at our activities.

We have two types of responsibility in wildlife management as we see our program: from the point of view of operations which does not include the administration of game control and then from the point of view of land use planning.

The Soil Conservation Service was created by the Soil Conservation Act of 1935 which instructed the Secretary of Agriculture to create a soil conservation service and outline its functions, including control and preservation of soil and conservation of natural resources, which is a big group of duties. Then in 1936 the Soil Conservation and Comstock Allotment Act was passed, the Flood Control Act was passed and one or two additional duties were imposed upon the Soil Conservation Service. All this has given us a pretty full program, and we are a little bit slow in working it out.

In the western states, in which we are particularly interested at this meeting, we are centering our activities in the operations field on the reestablishment of vegetation as a means of erosion control. That has direct bearing on game welfare. I don't think that statement needs any explanation. You can not have game unless you have some place for it to live. In the course of our efforts to reestablish vegetation we do everything from range management to artificial revegetation and various types of engineering activities. We have created a section of wildlife management, particularly to see that all the operations will be as useful to wildlife welfare as they can possibly be made. We need some game and wildlife men to check with the range men, engineers, etc., to see that wildlife gets as much out of the taxpayers' dollar as can be made. I don't think that this conference would be opposed to any such activities. On the other hand we have duties of land use planning, especially in western states, vegetation rehabilitation, as we call it, and reestablishment which can be accomplished only by proper use. You can not go out and seed 100,000 million acres of grass and pay for it. It boils down to handling stock properly, seasonal use and the proper type of farming, forestry use and that sort of thing. Out here, for example, we have tremendous acreages of public lands, 160 million acres of public domain. In addition to that there are a good many millions of acres of national forests, military reservations and Indian reservations; millions of federal acquisitions that have not been assigned to any particular use. Throughout the 75 years during which public lands have been acquired by the government there has never been an attempt to formulate a consistent and unified policy of use or management of federal lands. One portion of a bureau may run public lands for one purpose according to a particular policy and another portion or bureau may be doing an entirely different thing. There has certainly been no concerted movement to intelligently manage public lands for unified program. The Soil Conservation Act of 1935 instructed the Secretary of Agriculture through the Soil Conservation Service to work out programs for proper use. It is very fortunate that the Chief of the Soil Conservation Service recognized the significance of wildlife conservation sufficiently to create a section of wildlife management to see that wildlife gets a proper share in that program. I would like to develop that idea a little further, but there is hardly time. I would like to request that in any of our activities in the various states you consider the Soil Conservation Service as attempting to work out better wildlife living conditions, to help the administration of game and its management and that we offer our help wherever needed.

GAME MANAGEMENT

By IRA N. GABRIELSON, Chief, U. S. Bureau of Biological Survey

I have known Elliott Barker for a number of years and I always thought he was a friend of mine. Now, I am not sure that he is. He put my predecessor on the program yesterday to talk and then expected me to follow up and make you think I am as good as he was.

That is a dirty trick. Anyway, don't expect me to talk anything like Jay Darling.

Mr. Barker asked me to talk on the subject of game management. I told him if there was any subject I could help him out with I would be glad to do so. This is his assignment, not mine. I am not going to attempt to cover the whole field of game management in these few minutes. I would like to talk on three different phases of game management in which we have mutual interest.

There has been a lot said about game management; a lot of enthusiasm and a good deal of vagueness as to just what it is. Many opinions differ, but I define it as the application of horse sense in the management of wildlife resources. That is just about all it is. There are a lot of questions regarding the handling of game we have not found the answers to. There is and always will be a necessity for studies and investigations of wildlife and its needs. Conditions are changing all the time. It would not be possible if we had all the wisdom of ancient wise men for us to draw up a game management program for the entire state or any other area and have it work out as we planned. There are too many things over which human agencies have no control. The only thing we can do is set up certain principles and objectives, work toward them and meet the conditions which will inevitably affect a resource as susceptible to outside influence as wildlife.

Three phases I want to mention on the subject of interest to me in this position as administrator of game resources are: first, the problem of forestry and wildlife management. Stripped to its essentials and forgetting details, we can often confuse ourselves as to just what this relationship is by getting too specific as to detail. If a man were given a national forest or an area of forest land to manage entirely from a game standpoint it would be managed in one way. If entirely from a forest standpoint he would manage it from another angle entirely. If you were to have an ideal forest area to produce great amounts of timber in the shortest time there would be little room for wildlife in this forest. The ideal forest from a production standpoint is a forest with the trees as close as they can grow with available water and shrubs so that they will produce the greatest number of board feet per acre. If you could produce a forest of this kind it would be practically a zoological desert. Some exist in the Pacific Northwest and in the redwood belt of this State that have little or no wildlife. So dense, they are completely overgrown, completely shaded, no production of food within reach—not enough vegetation to take care of anything but specialized forms.

If you were to manage a forest from a purely game standpoint you would go to the opposite extreme. You would have a great variety of vegetation broken up into small areas of open and brush and a little timber country, and you would not produce very much timber. All you fellows know when you go hunting for deer, grouse or any other forest species, you do not hunt dense stands, but hunt along forest margins, along the edges of burns, through brushy patches. Those animals are concentrated because there is a restricted area where they can get the greatest variety of things to fill their needs.

If you were to approach this problem from that standpoint you would find a definite conflict between forest and wildlife. Fortunately it is not possible for us to produce forests of that kind over great stretches of country.

In the Federal Forest Service there has developed an ideal management in recent years which is a very definite contribution to production of wildlife species. Their idea is for sustained yield for producing timber on a long time basis. We should look at the question of wildlife on this basis. A forest is a group of trees which will grow, mature and eventually be removed. Forestry goes through certain definite cycles. There is a period of about 20 years or longer after forest production gets well started where there is a maximum production of wildlife. After the forests reach production stage, wildlife falls into a decline. I think we should realize that the National Forest Service has recognized it in their program. This concept of sustained yield used in handling their forests is the principal aim to be considered in forestry and wildlife management.

In some areas it is necessary to modify their practices. We must concede that those forest officials are there to manage and produce, some are for watershed protection, but fundamentally to produce lumber. We can hope to get a consideration of wildlife only if it can be fitted into that picture which I think we should recognize. From a wildlife standpoint the most fundamental thing to be done in the management of forestry lands is to break it up into as small units as possible from an economic and forestry standpoint. That will be the principal answer. It will have to be worked out on the ground. We can not get down and draw out a management scheme on paper, to be applied to any and all forests. It must be worked out in accordance with the needs of the locality. The smaller the harvest units can be the more forest area over a total unit can be broken up into different age classes, the closer they will come to produce what would be an ideal game setup.

There are many unanswered questions in this forestry-wildlife management program. We have had for a number of years a setup which might answer many of those questions. Many years ago there was passed the McNary-McSweeney bill which provides for funds for forest biological research by the Biological Survey on forestry management. This bill contemplated over a several year period the Biological Survey would get $150,000 yearly to carry on studies. The first appropriation was about $15,000. Increases came until it reached $45,000. The program called for $15,000 increases each year. Under the economy program the appropriation was cut back to $15,000 yearly, where it has stayed since. We are going to make an effort to get the rest of that authority because it is a definite contribution we can make to our program of forest management, to study forest biology from a wildlife standpoint, as contemplated in that act.

You fellows know as well as I that in the national forests we have the greatest potential area for big game anywhere in the United States. Whatever big game we may have in the future is going to be developed more or less on publicly owned forest lands, either state or federal. Your national forests in this western country are going to furnish the nuclei around which that can be built.

One other phase I want to mention in game management is its relation to agriculture and livestock interests. In many states whether they are going to have wildlife or not in those areas is dependent entirely upon the owners of the land, on the farmers and livestock men who control that land. In most states pheasants, quail and small game are going to be produced on land that is owned privately and managed for definite private purposes, or it is not going to be produced at all. There are many questions that will arise in connection with such a program. Fundamentally the question of its success will depend on the extent of cooperation, good will and understanding of the people who own that land. That is particularly true in the states east of the Rockies. Whether they are going to have any small wildlife or not will depend on the cooperation of the owners and controllers of that land as far as we can see and this apparently will always be the ease. I think we can help on that. I think we made a great start in these cooperative research units and demonstration units which Jay Darling spoke about. Those units have been set up in nine colleges in cooperation with state game commissioners. Each unit is financed by the Biological Survey, by private funds, funds from state game commissions and from the college. Each unit is controlled by a committee of three members, a representative of the game commission designated by that commission, a representative of the college designated by the college, and a representative of the Biological Survey.

The program is made up by this committee. This program must be devoted to practical problems that confront state game commissioners and officials in the administration of wildlife resources. We have no desire to dictate what that program might be. This is left up to the local people entirely. The only reservation we have made is that in the fundamental research program they do not select the same subject to work on. We have only nine stations and we need to know many things and we have reserved the right to suggest the fundamental research program that they be correlated with no two stations working on the same program. Each station has taken one major subject in addition to a variety of smaller subjects, demonstrations that are of immediate concern to state game authorities in that state. I believe it is working out as contemplated and that it will be more than a research program.

We have set up as many of the demonstration areas on state and other publicly owned lands where could be put into effect on a small scale the things we already know about management of certain forms of wildlife. These units are being developed now in certain localities. Any information obtained is placed in the hands of the public. These aim at the source of the various problems that are coming up, and is one of the greatest moves we have ever undertaken in an attempt to approach this problem from a practical standpoint. The units are widely scattered over the United States, with the idea of covering as many of the major ecological areas as possible with the money available. We have arranged for an exchange of information between units so that everyone has available all the information being gathered at other stations. Nothing is secret about it. Any of the other states are welcome to any information that we get. We hope to make this public and available as fast as it is in shape to be developed. Those stations

beginning in Connecticut, Virginia, Alabama, Ohio, Iowa, Texas, Utah, and Oregon, are widely scattered over the country.

Just to give an idea of the variety of problems which they are undertaking, here is a list of species on which the stations are making major study: whitetail and muletail deer, cottontail rabbits, muskrats, wood duck, mourning dove, raccoon, pheasant, quail and wild turkey. In each state the problem that is of most direct concern to that commission is being studied. This program, I think, can well be extended as time goes on to at least double the number of stations. There are about 15 or 16 ecological units in this country, about two really need to be divided and have stations in both parts of the region. There is enough difference, for instance, in the prairie country east of the Rockies, although the general ecological condition is about the same. I have great hopes that this thing will work out. I believe the development has been satisfactory from the standpoint of most of the commissions cooperating with us.

In this connection there is one other thing that may be of interest which you may not know. The Department of Agriculture has a fund known as the Bankhead-Jones fund for basic research. They have enough money from that fund for a very useful thing. There are a great many state agencies that are setting up different kinds of game management programs in cooperation with private land owners. Some of the land owners are setting up game programs of their own. We have set up some on our own areas in an attempt to find out certain definite things. We have enough money assigned to put one biologist and one agricultural economist to study farm ecology and farm management together to carry over different types and different states which are being tried out and experimented with to see if we can not develop some basic information that will be of fundamental value to any agency having to do with demonstrations of wild life resources. How long it will take to make this study is indefinite but it is under way and we have great hopes that out of it will come something of value to us.

One other phase of the thing we are concerned with is the management of migratory waterfowl. We are attempting to do on a nationwide scale the same thing you are doing in managing upland game resources in your own states, starting at a disadvantage compared to many states because you had a pretty good supply to start with. We are starting with a shortage of the two essentials in any management program—short of marsh lands to produce ducks and short of ducks to live there if we had the marsh lands. We believe the program is perfectly sound biologically and also economically. It is based on two things: one, we had to have more marshes and more water for the birds, and the other, we had to have more birds for breeding stock if we were to continue to regard migratory waterfowl as a species that might be wanted and utilized. We made drastic regulations last year. No use of telling you about that. To succeed it is going to be necessary to drastically restrict the kill of birds until we can fill up Canadian marshes with new stock and also new marshes by concentrating in states where ducks are being raised. If we don't do that there is no use in spending money to develop marshes.

I want you to know that as far as possible we want to cooperate in making these regulations in a way to be fair to everyone, but you will

appreciate the problem in that there are 48 different states and 48 different opinions on how to do it. We wrote every game commission in the United States and asked for certain information and recommendations. Out of them we got some very constructive suggestions which range all the way from unofficial recommendations of several commissions that the season be closed entirely for a number of years, to recommendations from some that we go back to the old days of killing as many as possible. I want you to feel we are going to take every way possible to draw up regulations that will evenly and fairly distribute what hunting is available and apportion the number of ducks to be taken over the entire country. We can only approximate that point of view. We do not expect to do a perfect job, but we believe our program is right and sound and I would a lot rather be damned for a few years by duck hunters than be damned forever for an entire depletion of the species.

We started on a basis of acquiring and restoring regions or lakes destroyed or partially so from one cause or another. We must realize, however, we can never bring back the number of ducks we had in years past. Millions of acres of marsh lands have been drained for agricultural and other purposes that are far too valuable for us to ever dream of putting water back on them. On the other hand, other millions of acres have been drained that are useless for any purpose or practically useless since the water was taken off. These are the places in which we are interested. We have purchased since money first became available, a million and a half acres of this kind of land. I know some of you have tried to buy land and appreciate what a hard job it is. I have come to have an aversion to all lawyers because the only thing they can do is to say "you can't." I guess it is all right, but the administration of the law in this country is beyond my comprehension. When we get through buying and are ready to actually take possession, there are a lot of gray hairs in the heads of the men handling the job. We have succeeded in buying and have under possession an acquisition of a million acres of land. The average size of these projects is 28,000 acres, so that you can see we are well along on many of them. We are proud of the job that has been done. Some mistakes have been made but we are trying to remedy them. The wonderful thing is not the mistakes, but how we kept from making a lot more under the pressure we were working. Lots of land has water on it now. In North Dakota practically all the water left to the State outside of the Missouri River and Denver Lakes is in migratory waterfowl refuges. I wish you could see some of them. The Upper Souris River in North Dakota, rises in Canada and comes across the border into wonderful duck producing areas. I saw it shortly after some had been drained, and some of it produced good land. Some land had been taken over by the State and County and we now have 100 miles of that river valley divided into two units which we call Upper and Lower Souris River Refuge which extends just below the Canadian line. A storage dam has been built to store 112,000 acre feet of water, and the dam is practically full with the spring runoff. This is to maintain a water level on down the river. At the upper end we are now building a low dam to maintain the upper six miles of the lake at somewhere near a normal level and making six miles of breeding and feeding marsh for the ducks. The lake is 28 miles

long. This big storage unit will also be one of the best fishing places in North Dakota. We are working with the Bureau of Fisheries, who have promised to help us. This lake will be a permanent lake because the water is 21 feet deep in the largest part. Below the dam we built two other dikes six miles apart. As the water rises from these units it flows into the marshes and maintains them. Down the river in the other 50 miles we have a series of seven dams across the valley for stabilizing the water level at a point where it would be best breeding marsh. Approximately one-half of the land area is in the form of marshes. We have a constant water level of from six inches to three feet over most of the units. Two or three streams that run in those units have an annual runoff enough to maintain them. We have developed those areas so that if there is not water enough for all, some can be maintained in actual condition and the rest discontinued temporarily. C. C. C. boys have gathered 160 tons of aquatic plants and planted them according to depth of water requirement. That is one of the major developments. There are many others. We have over one million acres of water in the country now and of course many projects are still uncompleted.

We have another thing in North Dakota which is as valuable as these larger units and that is that two years ago the North Dakota Legislature passed a law which said any land flooded would be relieved of taxation. Instead of draining, the owners want to store water as a result of the law. We have as a result something like 75,000 acres in small refuges scattered around the larger areas. It fairly gives us a perpetual easement to use this area for waterfowl refuge purposes in return for our building structures and doing necessary work of development. Thirty-nine of these projeets are nearing completion. Just before I left Washington, 100 others in which easements had been obtained from the landowners had been sent in. There will probably be another 100,000 acres developed into fine marsh and lowland that will benefit and materially assist our program.

The same thing is being done in South Dakota in cooperation with the Game Commission. The development of 175 small water area lakes and marshes is under way. They are getting relief labor to do the job. We furnish the supervision and the engineering and that is all it costs the Biological Survey to get these lands, and it is all it is costing the State Game Commission. It is my opinion that this is just as fine a part of the program as the larger refuge development. I would like to see it extended just as far as we can go, particularly in those nesting states. I believe when this refuge program is completed it will be seen that we have gone a long way toward the promotion of the migratory waterfowl program. If this program can be completed it contemplates the development of 300,000 acres in the states that are natural nesting areas for migratory waterfowl. It also contemplates the establishment of at least every 100 miles refuges where birds may rest and feed without being shot at and sufficient wintering grounds in the south to take care of concentrated birds. If we can build this system of refuges I believe that we will have a pretty fine breeding stoek to draw from on those refuges all the time as the birds fly north and south.

I think it will work out that way. How much chance we have of getting away with the program I do not know. There are two big "ifs"

in it. One is if we can get enough money and the other is to get the sportsmen to cooperate and rescind some of their privileges until we can build this thing back and get a supply of birds to take care of us. It will never be possible to kill 500 birds in a day, but I do believe we can develop the thing to the point where we can be assured of a moderate amount of sport in hunting these birds for time to come. We can all help. The Biological Survey can not do it alone. I think you fellows in the west can help in the program. For everyone who says you have to give us more privileges, there are three who say it is tough to do without the birds but we will do it in the interest of posterity. I have hopes that the thing will work out. We are asking your cooperation in letting your sportsmen know just how we are progressing on this program. Your cooperation and efforts to help develop this idea in your State is certain to be appreciated.

NECESSITY FOR UNIFORM BOUNTIES ON PREDATORS

By KENNETH F. MACDONALD, Montana Department of Fish and Game

I appreciate the fact that the subject assigned to me is of minor importance, but I do believe that it is a matter deserving of consideration by this Association. I wish to make clear at the start that Montana has had the predatory animal bounty control system. The stockmen have always been powerful enough to keep this system in effect. We, in Montana, have had practically every system of bounty methods that could possibly be devised. This has gone back over a period of 20 or 30 years, and I am sure there is no bounty system that has not been in effect some time during that period in our State.

At one time there was $100,000 made available for bounties through a portion of a livestock tax and from the general fund. In any state $100,000 would more than take care of the predatory animal work, but Montana had that much for years until it got so rotten the people took steps to change that method. At the present time the Fish and Game Commission is spending about $10,000 a year to control predators; $7,500 was taken from the fish and game fund by the Legislature and put into the bounty fund, which is administered by the Livestock Commission. The livestock men, in order to contribute their part to the program, have passed a law which puts an assessment on all livestock and poultry and other forms of domestic stock.

Last year bounties were paid on 14,000 coyotes in Montana, at $2 apiece, making $28,000. We have felt that the present system was absolutely foolproof so far as it could be, but this year under the system the bounties are paid on coyotes during May and June during the pupping season. This year we found the heaviest bounties are paid in the counties adjacent to Canadian territories and also bordering the states which have no bounties. The counts show bordering counties pay the heaviest bounty, which indicates we are paying bounties on animals taken from other states and Canada.

This year the bounties were exceptionally heavy. We started an investigation and found one man sent in 560 coyote pups. We found

that all these coyote pups he had sent in, he had taken the pains to skin in order to preserve the pelt, which he tanned. We found out by taking them to the laboratory at Helena and sending some to the Biological Survey that they were nothing more than gophers.

This year 300 were put in for bounties. We don't know how long this has been going on, but we are always sure it has been there, but it is our hope we will be able to bring these fellows into court and see that just punishment is meted out.

We find the Montana Commission is paying $25 on mountain lions taken any time during the year. We accused Idaho that we were paying bounties on mountain lions taken in their State, but on investigation Idaho found it necessary to put a $100 bounty on mountain lions. Our records show that during that period, very few lions were taken in Montana and at the same time the lion population in Idaho had increased and Idaho thought they were paying a bounty on our lions. Now they have a $15 bounty and we have $25, and that results in a reversal of the situation. We now have reason to believe that we are paying bounties on lions taken in Idaho.

That is something we think should be worked out. In order to remove any inducement to misrepresent the place of killing of a predator, we should adopt a uniform bounty system, and also a uniform system of marking the pelts.

At the present time there are no two states that use the same system of marking the pelt, especially of the mountain lion. In Montana we remove the head of the lion which is sometimes held for trophy purposes. We have adopted the system of making a slit between the shoulders and marking that with a stamp "MBP," which means "Montana Bounty Paid," but we find that other states put a hole in one or the other ear or jaw, or some other place, and we have no way of knowing whether a bounty has been paid in seven or eight other states. We think some method should be devised so that a uniform bounty and marking system can be adopted by all the western states.

There has been so much fraud in this whole proposition it really seems silly not to take some step toward correcting it.

Last year we found a man in Canada, an Indian, who had 15 coyotes and was raising pups and selling these pups for 50 cents each. People would buy them and send them to us and get $2.

I don't know what would be the best way to go about arbitrating this. We don't care what the system is, and it is only natural that a bounty should be paid on the mountain lion as they are taking a heavy toll on the deer and elk, but if we could establish a uniform bounty, it would serve to discourage this fraud that has existed in the past 15 or 20 years. I do wish that the representatives of the western states would give some thought to this and agree on some uniform system on bounty payments and markings.

Just another thing while I have the floor; I see Alvin Seale of Steinhart Aquarium here, and that reminds me of the distribution of fish. We have been up against a proposition of taking care of these fish from hatcheries to the planting place. For years we used the can method of distribution, putting 16 ounces of fish to each can. That was not successful. We have gone through the stages of the use of tanks and aerators, and have gone from that to the system of aerating the water by agitation.

Discussion

DAVIS: It all goes to show the old system in California is not so bad. Mr. Barker is going to broadcast and has asked me to preside in his absence. If you have anything to suggest regarding this bounty business, now is a good time to get it off your chest.

ECKERT: I would like to say we are paying a $15 bounty and when we receive skins they have to be accompanied by an affidavit. I think Mr. MacDonald is right when he says we should set a uniform price on bounties. We had some 278 taken out this winter. If we could get together, we would be glad to change our price.

DAVIS: Do you pay a bounty on anything except lions?

ECKERT: Lions, only.

DAVIS: How about Montana?

MACDONALD: Wolves, lions and coyotes.

LEWIS: We don't pay a bounty. We had one and we were buying the output of Mexico on coyotes. We hunt them and try to trap the coyotes and hunt the lions. Even if all the western states agreed on an equal bounty to be paid, your states on the borders of Mexico and Canada would be confronted with the same thing.

MACDONALD: I think we could get Canada to cooperate. I don't know about Mexico.

LEWIS: I believe that if the states would take the money they would pay out and hire the right kind of lion hunters and trappers, that possibly as much or more could be accomplished than on the bounty system. How much do you figure it costs for bounties?

MACDONALD: It runs between 25 and 30 thousand dollars. We think the most effective way is through the state trappers, anything but the bounty, but the sportsmen don't think it advisable to eliminate the bounties. They think there should be some in each game area, but the stockmen are in control in this matter in the legislature and they feel there is no value to any predatory animal and they should all be destroyed and that is the way to do it.

DAVIS: I understand some years ago that Washington had a system.

G. DAVIS, Washington: We pay $1 on coyotes; $5 on cats; $25 on cougars. They request from our director permission to hunt in a certain locality where animals caught there are taken to the game protector. They stamp them and then they take an affidavit and get it signed. So far it is working very well.

MACAULEY: We insist the hides be green and we have a right to refuse any bounty. I have refused bounty on several cougars and coyotes, and if I am not satisfied I can demand the carcass and do it that way. So far we have not had much trouble. Years ago, we did. In 1925 in central Washington I investigated and found where they were shipping cats in from Mexico to Texas and then to Washington and British Columbia. The bounty was paid by a girl in the auditor's office who didn't care whether it was a wild cat or a house cat. Some hunters were paid as high as five and six thousand dollars.

LATEST DEVELOPMENTS IN FISH FOOD STUDIES

By Fred J. Foster, U. S. Bureau of Fisheries

Due to the large number of charts used to illustrate Mr. Foster's talk, it is not possible to print it here. However, the paper will be published later by the Bureau of Fisheries.

THE ROOSEVELT ELK OF THE OLYMPIC PENINSULA

By H. D. Hinkley, Washington State Game Commission

There's an old maxim, that "you can't improve on the prodigality of Mother Nature," but from a practical wildlife viewpoint most of us have found that scientific practices have made it possible to improve on Nature. The problem of arriving at a happy medium in setting game seasons is not solved so easily, with sportsmen on one hand asking—and expecting—"open seasons" on protected game and the conservationists earnestly asking for rigid control of game at any cost. Then, you are familiar with the several intermediate factions, those with axes to grind, who urge passing of seasonal regulations favoring their own selfish ends. From all this potpourri of public opinion, state game commissions must make decisions which are designed first to properly conserve game and next to satisfy the majority of anglers and nimrods, fairly and unequivocally. Such is the situation faced by the Washington Game Commission in the matter of a proposed "open season" on the Roosevelt elk of the Olympic Peninsula during 1936.

The Roosevelt elk is a prize trophy of hunters. Reverberations from conservation agencies and private individuals during the past few years have echoed throughout the State of Washington. Let us briefly study the habits and background of this fine animal which now ranges in the "last frontier of America"—the Olympic Peninsula.

Named after that intrepid and beloved American sportsman, Theodore Roosevelt, the elk which roamed the prairies and mountains of the United States in great abundance during early colonial days, is a close relative of the European stag. It is by far the handsomest and largest member of the deer family in America. Roosevelt bulls often weigh upwards of 1200 pounds with the Yellowstone species weighing close to the 800 pound mark. Originally the elk was the most wide ranging of our hoofed game animals. It occupied all of the continent from north of Peace River, Canada, south to southern New Mexico and from central Massachusetts and North Carolina to the Pacific Coast of California. It appeared to be equally at home in the forested region east of the Mississippi River and on the open plains flanking the Rocky Mountains. Its range also extended from sea-level to above timberline on lofty mountain ridges.

Exterminated throughout most of their original range, elk still occupy some of their early haunts in western Canada, Montana,

Wyoming, Colorado and the Pacific Coast states. The last elk was killed in Pennsylvania about sixty years ago and in Michigan and Minnesota about twenty years ago. The main body of the survivors is now in the Yellowstone Park region.

The western wapiti or Roosevelt elk is almost wholly limited to the Olympic Peninsula, but is found on Vancouver Island, and parts of western Oregon and California.

The Washington State Game Commission has tentatively considered an "open season" on Roosevelt elk on the Olympic Peninsula and on this schedule: October 20 to November 1, in the counties of Clallam and part of Jefferson lying south of the Olympic Peninsula. These two areas have been the spearhead of much controversy. Population of Roosevelt and Yellowstone elk in the State of Washington is set at 10,000 with about 7000 to 8000 of this number ranging in the Olympic Peninsula.

Most of the Roosevelt elk in the Olympics range along the western slope, but a few are found all the way around the range where there is unoccupied country in or out of the national forest. There is unquestionably room and feed for twice the number and always will be on land which is mostly within the national forest and entirely useless for agricultural or grazing purposes. Elk have increased rapidly since they have been protected, in spite of those killed by peninsula residents, predatory animals and the ravages of the tick. The increase in the Olympic elk population depends very largely on the decrease of these destructive agencies. By wise cooperation ranchers, farmers, and residents can render very helpful and worthwhile service in protecting big game.

You are all familiar with the elk's struggle for preservation through the years. Indians through the centuries sought the elk for a food provender while later early settlers and the sturdy pioneers hewing a new civilization in the great Olympic wilderness leaned more and more upon the Roosevelt elk, the most rugged species in the world. Eventually, the white man learned that if the elk were to survive and thrive, adequate protective measures must be enacted. However, in many sections of the peninsula, before protective measures were enacted, the elk were exterminated by white settlers. With elk guardianship in force, the elk had only their wild animal foes to fear.

Setting bounties to arrest the destruction caused by predators was the next major step in the direction of elk preservation. Predators were preying on livestock and settlers took up the challenge as a "call to arms."

Elimination of the major destructive influences from the life of the elk resulted in marked increases in herds in favorable localities. Herds increased materially. Protected from the band of wasteful hunters, free from the persecution of predators, the elk increased beyond the limit of their natural food supply. This apparently began to happen about 1917, first in the Hoh River. In later years, other valleys of the western Olympics were seriously affected. The natural check has been a limitation of natural forage. Increase in the herds with a lack of an equal balance of forage soon became a new destructive force—starvation.

In many areas of the Olympics, Roosevelt elk have destroyed most of the natural food—plants, root and branch. What is actually happening is that the overstocked upland winter ranges, ravaged, denuded and stripped of food are reduced to the point where many acres of feeding area can never come back. Some conservationists go so far as to point out that these ranges will never be able to carry more than twenty-five per cent of the elk they would have, had they been properly managed before the damage was done.

Today, we find the central part of the peninsula inhabited by the starving remnants of once great bands, a problem which has reached a condition of range overstocking.

There seems but one adequate and feasible solution. After careful consideration of the question, the Washington State Game Commission is seriously considering a regional open season to stem the tide of elk decrease in all areas that are threatened with overstocking and the inevitable permanent range damage. An open season on all Roosevelt elk during the fall and early winter would soon return the Roosevelt elk to numbers the forage would support. Many of the Roosevelt elk may be likened to park bears which have lost their fear of man through semidomestication.

In support of the Washington State Game Commission's proposal to thin the ranks of Roosevelt elk for the good of the species, it can be said that this action should have no detrimental effects on Olympic Peninsula elk. It will tend to promulgate the species and safeguard this grand animal for future generations. Because of the rough terrain and mountainous topography of the Olympic Range, particularly in the region of the contemplated open season, only the hardiest of hunters, expert woodsmen and sportsmen with training in outdoor life will be apt to penetrate this rough country. Therefore, the district will not be overrun with hunters, as might be supposeed, but will, instead, be largely restricted to the "fit and able" among nimrods.

It is a peculiarity of Roosevelt elk that generations of the animal range close to the same grazing area. Efforts have been made by game forces to drive the animals to more fertile and forage-laden valleys, but to no avail. Thus, we must face the truism that often a herd of elk may be seen slowly starving on overgrazed land with a fertile green pasture of forage just over a ridge a short distance away.

Complaints of ranchers, truck gardeners and farmers that elk become—out of necessity—a nuisance and are feeding on vegetation and produce of these peninsula residents have been investigated and substantiated. The forage shortage on the Roosevelt elk range has caused bands of elk to seek food in the lowlands, even to grazing in and about the premises of residents. Predatory elk feeding under such conditions are a real menace to public property and action must be taken to halt this destruction. An open season in these districts would curtail the migrations of elk into the vicinity of residents' property.

Sharper lookout can be kept on predators preying on young elk, with perhaps, a raise in bounty payments as an added inducement to bounty hunters. In the spring of the year the bear and cougar cause probably the greatest destruction during the calving season. The bear is one of the principal menaces that we have on the Olympic Peninsula as a predator on elk. Cougars in the State, due to organized predatory

drives and the success of licensed bounty hunters, are being held pretty well in check. Bobcats also prey on young calves in the springtime.

Through the efforts of licensed bounty hunters, 1935 figures show that a total of 53 cougars were killed in Clallam County and 5 in Jefferson County with 285 bobcats taken in Clallam County, and 25 bagged in Jefferson County. Clallam and Jefferson are two counties in which an open season on elk would be permitted.

In the interests of conservation it is well to point out that protection of any wildlife is a problem wrought with many positive and negative angles, each embracing the earnest conclusions and convictions of various agencies and individuals. If regulatory measures are applied to preserve the posterity of Roosevelt elk, it may mean that elimination or curtailment of excess numbers is the best safeguard and remedial measure available to protect the perpetuity of this species.

Public sentiment and overzealousness on the part of eastern conservationists, agencies and individuals who are clearly out of step with the range problems of western game, are common hindrances to progressive application of practical game management practices. Laxity in game management and systematic guardianship of their vast game resources has caused many eastern states to launch an elaborate program of restoration of game birds, fish and big game. The State of Washington is guarding its game assests jealously and is expending every effort to save it for future generations. Washington game must never reach *status quo* and the State Game Commission will continue its pledge to this commonwealth to strive to foster and promote the best interests of conservation and guardianship of a great wildlife heritage.

BARKER: The next speaker on the program this afternoon is a man who helped to make this Association possible—perhaps more than any other man—the man who regularly meets with us and without whom no meeting would be fully complete. I am not going to tell you very much about him—I might get off on the wrong foot, but I am going to introduce Dave Madsen to talk on whatever he pleases.

ADDRESS

By David H. Madsen, U. S. National Park Service

Carl Shoemaker said today the Taylor Grazing Act in itself was not so bad, the administration of the act was what did not satisfy the public. At the same time we are hearing a great deal of talk about coordinating government bureaus in order to get better cooperation and more and better results. My own opinion is that none of us have learned how far we can go in cooperating with one another in bringing about conservation of wildlife. I am going to paint a picture of one area in which there is cooperation between state and federal agencies. I refer to Yellowstone National Park. We have with us today three game commissioners who represent this park, from the states of Idaho, Wyoming and Montana, all of whom are interested in what goes on in Yellowstone Park. There is more game there than in any other area of that size. The elk herds once on the way to extinction are now so overgrown that we are unable to take care of them. We have all the buffalo

we know what to do with. We do not have an increase of deer or antelope or mountain sheep and that is largely due to an overgrazed range and we are not trying to correct it.

In Yellowstone Park and vicinity, there are more trout than in any like area in the United States. Mr. Foster has shown that the Bureau of Fisheries has taken as much as 38,000,000 eggs from Yellowstone Lake.

I want to point out to you what I mean by cooperation. At the time Mr. Foster came into the Bureau of Fisheries and I went into the National Park Service, there was absolutely no method of cooperation between the agencies I referred to. The Bureau of Fisheries, the Park Service, the Biological Survey and the Forest Service was each going its own way. The point involved was some sort of control over a number of deer, antelope, mountain sheep, fish, distribution of eggs, etc. It is a very complicated picture. The herd grew to a point where it was very much in excess. We were faced with the problem of reducing the herd. We did not want to kill the elk leaving the Park, which are the property of Montana; the Montana sportsmen are entitled to take them, so it would not be proper for us to tell Montana we were going to take about 4000 head of elk. Therefore, we met with the Montana Game Department to determine the best method to take 4000 head of elk out of this band each year. They were fully cooperative and extended their season. In Washington, the people cooperated in the handling of the elk herd in reducing them to the capacity of the range. So much for the big game.

Now let us turn to fish. The agreement is that the park waters will be stocked. There is no friction. There is no duplication of authority. There are not too many men; and yet the picture of cooperation is complete. Mr. Foster and his corps of men go into the Yellowstone Park and take 38,000,000 eggs. These eggs are hatched and they are ready for distribution. We then decide where and how these eggs shall be planted in the Park. He, in turn, supplies state game departments with a certain amount of eggs, thus again bringing about perfect cooperation of the distribution of a product which belongs to the people. He plants the rest of them outside of the Park.

We had trouble with disease among elk, etc., in Yellowstone Park. Mr. Bill Rush, who originated the investigation, under the joint direction of the National Parks and Biological Survey, made a study on bringing about the same results and, after this, these game departments were at odds. Everybody believed that everything we did was against them. We have brought about cooperation on this and we didn't need any law to do it. We worked together to do it. So now we talk about the coordination of government bureaus. The best results can be brought about through cooperation between the several agencies involved. Whenever we wish to establish a national park area, without any exception, there has been objection on the part of some people.

The sportsmen have, as a rule, objected to enlargement of national park areas on the theory that the game becomes bottled up in the park and they have no opportunity to hunt. The purpose of the national park policy is to maintain the areas under its supervision in as nearly a primeval condition as possible. That means everything in the national park and consequently there is no hunting allowed in the parks.

Now, I am not inclined to believe that the national parks are in any way detrimental to the sportsmen's interests unless they should be extended to the point where they take in an all-year range and exclude hunting. Yellowstone Park is an example. Four thousand elk can be killed annually in Montana in addition to those killed elsewhere, probably making more than eight thousand elk that are killed annually outside of the park. These animals are what I consider the overflow of that great National Park. Except for the Park, there would not have been so many; and that is no reflection on the agencies, because the Forest Service comes and sets aside game refuges and excludes livestock therefrom; but the national parks do become a reserve or a game preserve out of which the overflow goes to the sportsmen on the outside. The only danger in taking away any of the benefits which the sportsmen receive is to extend the area to where it takes in the all-year range.

In reference to the fish planting policy of the National Park Service, every man interested in fish distribution has regretted the indiscriminate planting of fish in all kinds of waters. The National Park Service has suffered along with other areas by the reason of this unwise distribution of fish. Our policy is this: in waters where there are now no exotic species, none will be introduced. The native species will be protected. In waters which are more useful as scenic attractions and where there are no fish, there will be no stocking at all. I could refer to several lakes where it doesn't look right to see fishermen. We have religiously avoided planting fish where pollution occurs—we are going to try to maintain in the national parks, in the waters that are not already contaminated, a clean stock of native fish.

It happens now that Yellowstone Lake contains the only very large stock of native trout except Georgetown Lake in Montana. Although our fish planting may not be so successful, it must be remembered that our job, according to law, is to maintain the parks in a natural primitive condition. In waters where exotic trout have already been introduced, we will maintain them.

I want you to know that I certainly appreciate, as does my division of the Federal Government, the very friendly attitude which the game departments have for the Park Service, and I wish to assure you that in every area which is proposed as a national park, I have never overlooked the rights of the sportsmen. Also I want to say to you that the paper which Mr. Hinkley read today was a very excellent contribution and gives a very excellent picture of that area.

ADDRESS

By W. L. Dutton, Chief, Division of Grazing Service, U. S. Forest Service

Mr. Barker asked if I would give you a short expression of the so-called new grazing policy. I don't suppose that one could select, if one tried, a more difficult subject to address to an audience when one has just taken over a new position. One of the most outstanding reasons is that the game wardens and commissioners from the eleven western states know the very vital interest that exists between live-

stock interests and adjacent forest land and the game thereon. I am a western man and I do not yet have the Washington viewpoint. So I am glad to make a few remarks here today.

For the period 1924 to 1934 the Grazing Division of the Forest Service did have term permits; and with the expiration of the ten-year permit period, we had one year during which no permits were issued. At the same time we had initiated an economic survey to determine whether the basic principles on which we were making our distribution were sound. That survey was not completed in time so the issuance of permits was delayed; but beginning with the 1935–1936 period, the decision was made by the Forester's office to again issue term permits. By way of experience, prior to that decision, a conference was held, attended by representatives of the two livestock associations and several western senators and congressmen. From the very beginning of that conference, it was apparent that there was no possible way there of ever harmonizing the interests that had to do with the issuance of grazing permits; but after seven or eight days of conference, there was published in the newspapers the announcement of the new grazing policy and those two small paragraphs which outlined the basic principles, with an avalanche of criticism from all over the United States. I want to read to you the two short paragraphs which resulted in that avalanche of criticism:

"(1) The term permits for the period 1936 to 1945, inclusive, will be issued for preference numbers of stock within the maximum limit and the commensurateness of established permittees. No reductions in preference numbers of livestock will be made in 1936. Each term permit will contain a clause specifying the reduction percentage that can be made for distribution. Such reduction, when taken together with reduction for distribution made in 1935, shall not exceed 20 per cent in any case for the term-permit period 1936 to 1945, inclusive. No greater reduction than five per cent will be made for distribution in any one year.

"(2) The maximum reduction that can be made for any or all purposes shall not exceed 30 per cent, or 15 per cent in any one year, for the period 1935 to 1940, inclusive. At the expiration of the year 1940, such reductions for protection can be made in term permits as the circumstances justify."

Now then, it is evident to those close to the situation just why we had this storm of protest. In the first place, the large established livestock operators have been for many years stocked above their present permit total allotments. The Forest Service contends that the right to regulate grazing must rest at all times with the Federal Government. Therefore, they could not see fit to grant a long-time permit without any provisions for any purposes. The larger operator, then, was not satisfied with the new policy even though he got the ten-year permit. The smaller operator within the forest with a small number of stock is not satisfied because he believes that we have not made sufficient provisions for a further distribution and the small operator now on the forest or the large operator who does not now share the use of the forest, feels that there should be a greater division of the permit allotments.

Another factor of dissent is tied up in game conservation. I don't agree with some of that dissention or with the man who believes

that all livestock, both sheep and cattle, should be completely excluded from the national forests; so, as I say, we felt that the new policy goes just about as far as it is humanly possible to harmonize those conflicting views.

Some two years ago at a national meeting of the Forest Service, with representatives from every region of the country, basic principles were laid down, and I regret exceedingly that these principles have not been given as much publicity as some of the others. There has been some dissent in the past several years. This ties in with what Mr. Gabrielson told you in connection with the changed viewpoint of what constitutes national forest administration. In other words, while I have been in the Forest Service, I have noticed a slow but gradual change in that region, an area devoted exclusively to the production of trees, and since the laying down of this new principle, I know there has come a decided change in the whole program of wildlife.

(1) The wildlife of the national forests is a product of the land, along with the forage, timber and the other resources. Therefore, this is a resource publicly owned for hunting.

(2) The management of wildlife will be properly regulated for the occupancy of national forest lands and the orderly utilization of all natural resources. The resources rendering the highest form of public service will govern the decision as to what areas and how much should be devoted to wildlife management.

(3) The Forest Service will seek the advice of other scientific bureaus of the federal government and the states having to do with wildlife management. Those are the basic principles under which we are now operating.

I know when the Forest Service entered the field of conservation some years ago, we were the only agency having to do with grazing on wild lands. Today, in addition to our 46 state planning boards and some 350 county boards, there are 39 federal agencies which have to do with the administration of wildlife, 16 agencies deal with grazing, some 16 deal with administration of timber and 5 are conducting experiments and demonstrations in the administration of wildlife. I mention that to show the very great difficulty that the agencies face in working out these plans and the tremendous amount of study that must be made on the part of the various agencies. That is a pessimistic picture but while I have been traveling I have seen enough of cooperative examples to almost make an optimist out of me. We hear of this conflict but when we come out on the ground we find the state game warden, the president of the protective association, the representatives of the other groups and the Forest Service all on the ground working things out in an amiable solution. In California men are working with the U. S. Bureau of Fisheries, and the Forest Service is working out plans in fish management so I see I am an optimist and there are possibilities of this cooperation.

Yesterday some of the delegates in this room asked some very important questions: George Aiken from Oregon and Newell Cook from Utah raised the question as to just how we were going to settle this difficulty between sheep and cattle on one hand and wildlife on the other. Gentlemen, there is no other way that we can have game management unless the agencies sit down together and say we are going to have so many of each animal because we came up here and

we find 10,000 head of deer on an area of 50,000 acres that is occupied during the summer season by sheep, cattle and deer. This summer range's vegetation is all consumed by these three classes of animals in the summer and these deer move in October to occupy an area of land with no vegetation at all. We look into records and see that the supervisors have reduced the stock on that range $33\frac{1}{3}\%$. These are not the only problems that range managers have to work out. One other thought on this: I notice a trend on the part of this meeting to urge the greater delegation of authority by state legislatures to state game commissioners, and I make this comment—that if all states in the Union, especially those states in the west, where big game is found in competition with livestock, would get together with the other interested agencies and work out a range management plan, we would not have any of this conflict as to what we are going to do on the opening and closing of the season. No effort should be spared to attempt to get complete delegation of such authority. I would sum this up by saying: the Forest Service intends thoroughly to define the proper place of wildlife in the national forests. The Forest Service, in carrying out these basic principles, has established a new Division of Wild Life Management, taking that responsibility out of the old Division of Range Management, yet requiring the complete coordination of cooperation between the two because you know we can not separate big game and domestic stock management in the areas where we have established a new division; and a technical personnel will be developed and plans will be carried out just as rapidly as possible. We have our cooperative agreement with the Biological Survey and we work with them. The same holds true with the Bureau of Fisheries. We recognize both these bureaus as agencies for research.

So I say that in the carrying out of this program we urge your support and complete cooperation in working through and with the various states; and as for my own Division, we do not want to do one thing that will take away from the states any lawful powers which they now possess. Thank you, gentlemen.

FOREST SERVICE POLICY IN GAME MANAGEMENT

By H. L. Shants, Chief, Division of Wildlife Management, U. S. Forest Service

Members of the Western Association of Game and Fish Commissioners, ladies and gentlemen: I am glad that Mr. Dutton had a chance to outline to you the new set-up in the national forests, the fact that we have divided the old Division of Range into two divisions. Mr. Dutton and I started the first of June to look over the western ranges and I feel in some way very fortunate in being able to be here with you; but rather unfortunate that I have to talk to this group so early on this inspection trip.

We have only covered four of the western states but we found very little conflict between our two divisions in that area. If we look at our

problem we must realize that land, "the foothold of all things," is basic to any state or national program.

In less than 200 years of settlement we have destroyed almost all of our eastern forests. Formerly unbroken and comprising more than a million square miles, less than one-fourth is now in merchantable timber, about one-half is farm land and one-fourth waste land.

Of the farm lands in the United States we have badly impaired 125 million acres, partially impaired 100 million acres and impoverished 34 million, a total of about 259 million acres partially or wholly destroyed or 13.6 per cent of the total area of the United States.

Even more astonishing is the degree to which the western range lands have been abused and neglected. These lands occupy about two-fifths of the total land area of the United States. About one-half the area of these range lands is in private ownership and about one-third in federal. According to the best estimates available these areas have been depleted to the point where it may be safely said that three-fourths of the total area is on the down grade.

Excessive or badly managed stocking is the outstanding cause of this condition and the present situation shows no immediate possibility of solution since the range lands now are stocked with about 17.3 million animal units when they are estimated to carry only 10.8 million animal units. Of the 728 million acres of western range lands, 523 million, or 72 per cent, are still subject to unrestricted grazing.

The unrestricted expansion of agriculture has encroached on the short grass and already about 25 million acres of this land which should never have been plowed has been abandoned and is the source of much of the dust which has blackened the skies of the Great Plains region during the past several years.

One-third of our land area, 589 million acres, is partly eroded and three-fifths of this area is adding silt to rivers and reservoirs.

Probably more than 50 years will be required to restore the damage resulting from 50 to 100 years of unrestricted use of the range lands.

The wildlife picture is even more discouraging. This is due largely to the destruction of the natural feeding and breeding grounds. Some of this change was inevitable, but it is a change nevertheless. The rich grasslands and swamps of the East and of the great prairie region have been drained and planted to produce agricultural crops. The great prairies and plains, the natural home throughout the world of great herds of herbivorous animals and their attendant predators have been turned to fields of corn and small grain. The valleys of the West, the winter home of great herds of game and the breeding ground of waterfowl, have been appropriated for domestic stock and drained or irrigated for the production of crops. The public domain has been eaten out by bands of sheep and cattle, and become less suitable for wildlife. Throughout, streams and lakes have been subjected to industrial use with little or no thought of the effect on the wild animals which occupy them, and even the great spawning waters which supply that magnificent "rearing pond," the ocean, have been damaged by man's careless use.

There seemed to be no way to stem this gradual destruction of the land and its resources until a program of conservation swept this country in the early part of this century. The national policy was

changed from that of giving away land to anyone for any purpose to a tendency to conserve areas for the use of all, to look to the best future use of land and to protect and perpetuate what nature has given us.

The national forests were established to conserve the resources of timber, grazing, wildlife and recreation, for protection or watersheds, stream flow, power, and to prevent soil erosion and floods, and a national park system was dedicated to recreation and the protection of scenic wonders for the benefit of all. This system of parks and forests is the envy of every nation in the world today, and should be the pride of every American citizen.

This conservation movement has now been extended and broadened. A national resources board, extending into state, county and city, is at work trying to plan for the future in terms of the present. Land can no longer be considered only from the point of view of immediate use. Permanent usefulness must not be impaired by present use. The day is past when man has the right with public approval to despoil for all time the earth on which future generations must live. To this end the lands and the resources administered by the state and the nation must be managed. The great erosion control program and the Wildlife Federation headed by Jay N. Darling, are expressions of the national interest in conservation and restoration.

The Forest Service is charged with managing over 200 million acres of land, or more than one acre in every ten in the United States. This is probably the greatest opportunity and the greatest challenge in land planning ever accorded any government agency or any other agency within the history of man. It demands the proper use of land measured in terms of its ability to produce for all time those things which lead to man's fullest expression. On the basis of a permanent policy we must raise this land to its highest social and economic use. Our program for the future must look to the land as the basis on which to build a home for man, surrounded by the bounties of plant and animal life.

Although it shows the least degradation and the greatest area of land which is improving, the Forest Service is determined to stem the downward trend and bring its acres back to normal production. To this end reduction in stocking with domestic animals has been undertaken where necessary, with the belief that soon we can return to a safe optimum far above the present potential production.

Basic principles to be observed in this program are to develop the present in accordance with the proper future protection of the various resources. First and foremost must be the protection of the watershed and the soil by maintaining a plant cover, by the employment of proper methods of lumbering, grazing of domestic and wild animals and the control of recreation practice; by the protection and development of soil, by stopping erosion loss, by spreading water, by equalizing stream flow and by preventing floods; by insuring the retention or reproduction of valuable species of trees for lumber and protection, shrubs for protection and browse, and ground cover for protection and for grazing animals; to consider insofar as possible and not impair the future usefulness of the land or other resources, the two great western industries, lumbering and grazing, upon which thousands of our people and hundreds of our communities depend for

a living; to manage our wildlife resources by providing protection and maintenance of the natural environment of cover and food so as to produce the greatest crop and thereby contribute to the aesthetic and recreational value of the forests, lakes and streams, and to insure the greatest maintained take of game and fish.

Recreation in its broadest sense includes not only the use and enjoyment of the forests by animals, campers, tourists and nature lovers, but also by hunters and fishermen. In the multiple use program we must determine the best present and future use of the land. We must not ignore either present demand or future good. Fortunately, in most cases the best present use is likewise the best future use.

Protection of watershed and soil must be insured, whatever the use, and there may be lands on which this consideration may exclude any other use. As a rule, however, timber production, grazing by domestic stock, wildlife and recreation will have to be considered and a balanced program worked out. The best use may not always be multiple use. Certain areas will produce timber and little else. Parts may be set aside for wildlife alone. Recreation may, in some cases, be the highest use.

Wildlife means all forms of life, and its development and maintenance rests on the physical base, the environment. For herbivorous animals, most of our big game, the plant cover is basic and should be so managed that it will produce the greatest amount of food for animal use year after year. This greatest production can only be maintained if the cropping by browsing and grazing is not in excess of the optimum amount. If overgrazed by 10 per cent too many animals for a single year, the forage is reduced rapidly and a return to balance may mean years of protection and a reduction in grazing animals to at least thirty per cent below the optimum. Permanent damage is often done. This is especially true of browse. The damage resulting from overstocking, which is rarely noticed until excessive, is a disproportionately forced reduction in animal units within a few years. Climatic conditions are a major consideration in this connection. A desert browse which has required 50 to 100 years to develop, when once eaten back will not return in one generation, and amounts for us to nearly a permanent destruction.

This is by all odds the most serious factor confronting our big game herds at the present time. Unfortunately the set-up of the national forests does not afford a balance of summer and winter range for migrating deer and elk. As a rule, in the south and more desert areas the summer range is restricted, but in most of the area the winter range is vital. Adjustments along this line are badly needed. Except in the luxuriant areas of chaparral or west coast thicket, the browse of the semi-desert type can be replaced only slowly and requires many years to overcome the effect of a single season of overstocking. A few years of heavy grazing removes entirely the browse on which animals must subsist during the winter. Often the permanent browse plants such as juniper, bitterbrush and deerbrush are trimmed to a deerline out of reach of all but the taller animals. Another line, a snowline, may cover up the lower plants. Cattle and sheep have often been removed from these lands and a rapidly increasing deer, elk or antelope herd will take up the slack in a year or two. Cattle

and sheep can easily be moved but deer will starve to death within a few miles of good browse, and every attempt to overcome the instinct of remaining on their own range has failed. Determining the danger line is not a matter of counting the animals. It is a matter of feed and can only be determined by one skilled in the study of the range, its browse plants, and their carrying capacity. Counting the number of deer may be necessary in determining a percentage reduction of the herd, but to rely only on the count or number of deer as a basis of determining whether or not there are more than can be fed is like determining your bank balance by counting the number of blank checks in your check book or by the number of bills you have coming due at the end of the month. In many cases we have done this very thing, have overdrawn our account, lost thousands of deer by starvation and left a country depleted for many years to come. Any rational program can not support this destruction of range and loss of deer. There must be a better way—one that will preserve the forage and yield a continuous crop of deer. We have been "killing the goose that laid the golden egg." Nature lovers and sportsmen want more deer but forget that food is necessary and is the limiting factor in forest and desert ranges. It is a renewable asset if not destroyed by over-use. In this case the deer are the "golden egg" which we all desire and the "goose" is the browse from which alone can come quantity and quality of deer.

To maintain the environment at peak production means understocking for protection. This results in maintaining the highest possible carrying capacity throughout the years, and the greatest potential production of game animals dependent on the plant food. The object of good management is to produce the best crop in quality and quantity through a long period of years. The quantity of game has received more consideration than the quality. But the latter is becoming equally important, in big game, fish and fur bearers. Even though we may be responsible for the program for only a year or two, we can not allow personal selfishness to impair the future of the resource.

The whole plan for managing our game animals is so inflexible that those who wish to carry out good practices are unable to do so. The game refuge, which is admirable in purpose, is often vicious in practice. This is especially true of large refuges. Based partly on the assumption that the deer will distribute themselves to adjacent areas, which has not proven to be the case if we exclude the annual migrations, they usually, if successful, result in concentrations which soon overbalance the food supply. Often established by legislative action, they can not be opened on a basis of biological necessity and must be terribly overgrazed before public opinion can be secured to enable legislatures to act on the matter. As a rule, we are about four or more years behind and the reduction comes by way of starvation and permanent damage to the browse. Conditions are much better where the game commissions have power to set up and open refuges on the recommendation of those who are making a constant study of the conditions of the vegetation base on which the deer must live. There is, as you know, a further complication where elk are allowed to become over-numerous. They remove much of the choice food of the deer by establishing a line at about 9 feet, far beyond the reach of

deer. This operates on both winter and summer range. Plants when once cleaned to the deer line at about 5 feet, or the elk line at 9 feet, do not, as a rule, put out any new growth below this line. They continue to grow above and produce seed but are otherwise valueless to deer and elk. Antelope also produce a browse line on overgrazed ranges.

An increased opportunity for wildlife does not mean overgrazing. Elk and deer are as destructive as cattle or sheep, and may increase as rapidly. Over-protection of elk, deer and antelope in most cases means first of all destruction of the food base and later the herd itself. It would be unthinkable to allow cattle and sheep to multiply on a given range without control by cropping. It is equally unthinkable with deer, antelope and elk. The management of game requires proper cropping by man or the removal of the excess by predators. The best means of securing the proper destribution of animals like deer and elk is by controlled removal from congested areas and protection in areas of sparse distribution.

We believe management can be secured in time by a cooperative program. This management will enable us to distribute our game over the whole area suited to its production, will allow us to work out hunting plans which will protect and maintain our resources in food at its highest productive capacity and avoid wholesale starvation, will enable us to avoid the development of undesirable sex ratios in the herds, and will, in short, give us legal authority to maintain practices which are sound biologically. The advantages of a cooperative program are chiefly that it strengthens the state departments and that it carries over to every part of the state and nation the good practices which otherwise might be limited only to one of these agencies.

The Forest Service asks your cooperation in conserving and improving the environment and asks the privilege of cooperation to this end with you in the management of game and fish. We come with no selfish aim other than conservation and protection of the forest resources with which we are charged by law and which we believe we have both the duty and the right to manage. Under the present practice the game, fish and fur bearers yield income to the state and very little or nothing to the national government. We can have no ulterior selfish interest in wishing to manage this resource in such a way as to yield to the people of the United States, through you, the greatest crop of fish, game and fur bearers.

Within the limits of our multiple use program we wish to produce the best possible home for big game, upland birds, fish, waterfowl, fur bearers and other wildlife. We wish to raise the best and largest crop for recreation purposes, hunting, fishing and trapping. We wish to cooperate in every way with state and other agencies to this end.

It is our wish to strengthen the state game departments and to see them freed from unnecessary legislative restriction in the interest of producing more fishing and hunting in the national forests by increased production, by better law enforcement, by lessening conflict of purposes, by education of the public to the importance of our wildlife resources and wildlife management and by favoring stronger state wildlife organizations; and to cooperate in every way not only with state and other wardens and commissions but with any other agency interested in developing the wildlife resources, in order to extend

these resources to the whole country. It is possible, with a closer cooperation between the state and the Forest Service to accomplish more than either agency could if it alone were in control.

There are no essential differences in the objects sought by the Forest Service and the state game departments if viewed from a distance and as a long time program. True, there are differences of opinion and these come mostly from those who stand close together. At a distance they are lost in the general picture. Usually the most violent differences come from those who want the same result but approach it from different backgrounds and want to accomplish it by different methods.

The agencies interested in wildlife do not see eye to eye. There are sects with different beliefs. Some hunters want more animals whether there is feed or not and regardless of what happens to the environment. They count the deer but never look for deer food or vegetation. The nature lover may take a similar stand and want no deer killed no matter how short of feed they may be. He may ask that they be fed as domestic stock without consideration that this not only domesticates the herd and subjects it to possible disease, but that it merely carries over more deer to further overstocked range.

What would you do with the man who shoots everything he sees, with the man who shoots nothing and wants nature to take its course, with the man who would preserve all of the ruminants and preserve all predators, with the man who would kill all the predators, with the man who would rather feed 52,000 deer a year to a thousand mountain lions than permit the hunters to take them, with the man who wants wolves protected, with the man who would throw all the sheep and cattle off the national forests, with the man who would not license any boy or girl under 21 years of age to hunt or fish, and with the man who would surround the national parks with a 50-mile strip of breeding ground and another 50-mile strip where animals could roam at will but could not breed?

There are many of these differences of opinion, none of which are of major importance, and all of which would be somewhat satisfied by a properly managed program of wildlife protection and propagation.

Our job is too big, too important to the present and the future to be disturbed or deflected by extreme measures or by the opinions of small minorities. To the state game conservation departments we extend our cooperation in managing the forest environment through game management so as to bring to them the best possible crop of game and fish. You are handicapped and hindered in some cases just as we are by laws and legislation which must be carried out. Ultimately we hope these may be changed to increase the efficiency in carrying out the responsibility placed upon both of us in our respective positions. We hope that in all cases we can aid you in a planned program and that you will give us the chance to cooperate. Our purpose is:

To raise the forests to their highest potential production capacity.

To balance the needs of a multiple use program.

To consider the social as well as the economic.

To cooperate with state agencies to accomplish these ends and in this way strengthen the wildlife program beyond the forest boundary.

To bring every possible agency to aid the program.

To broaden our program to increase the protection of species which are in danger of extermination.

To encourage citizen organizations by a program of education to join in an attempt to attain for the future the security of a well managed present.

The watersheds and soils must be protected. To this end we must not permit bad practices in recreation, grazing or wildlife management. We are charged by law with the responsibility of protecting and developing the national forests. To this end we can not allow destruction of the browse or grass cover by overstocking of domestic or game animals. To allow great herds to starve for lack of browse is to repeat the errors of the cattleman and the sheepman. They have paid the price of a lack of a planned program. We do not want to see the wildlife program hampered by a repetition or a continuation of this haphazard practice. There are many unknown facts important to a well managed program but to await the slow process of research before we attempt to apply what we now know would be fatal. We must use the facts and experiences we have at hand and change our policies as fast as necessary in the light of additional research.

Where laws permit you can help us in making necessary reductions or give additional protection and where they do not permit you to do so we should work together to secure a change. Federal lands must be protected from wasteful and destructive practices but the Forest Service never desires to act alone or independently if it is possible by cooperation with you to avoid such action.

Discussion

LEWIS: I think that is one of the most complete papers that has been read with reference to the game situation in our eleven western states. I have known Dr. Shants for a long time in Tucson and we hated to lose him; and the State Game Department of Arizona regretted it more than any other group in the State but we hope to see you around occasionally.

If there is anyone here who would like to discuss what we have just heard or ask any questions. I am sure he would be glad to attempt to reply to any questions that might be asked him.

MOFFITT: I would like to ask the policy as regards wilderness areas. We have that condition in this State.

SHANTS: I would like to have Mr. Dutton answer that.

DUTTON: The Forest Service has full authority on the ground, and without taking it up with the Secretary of Agriculture, to completely exclude domesticated stock from any area whenever necessary; and if at any time persons interfere or threaten to interfere, we can exclude stock on the ground.

BARKER: Any further discussion on this question? If not, I believe that we are now about ready to hear the reports of the different committees that have reported.

COMMITTEE REPORTS

Finance Committee

KENNETH F. MACDONALD, Chairman ---------- Montana
GEORGE K. AIKEN ---------- Oregon
A. J. MARTIN ---------- Wyoming

Resolution Committee

NEWELL B. COOK, Chairman ---------- Utah
AMOS ECKERT ---------- Idaho
HERBERT C. DAVIS ---------- California
S. L. LEWIS ---------- Arizona
GLENN DAVIS ---------- Washington

Resolved, That it is our belief that the highest benefits for wildlife and wildlife resources can be achieved through a consolidation of the principal federal agencies now engaged in administering wildlife on all of the public lands of the nation including Indian reservations. To this end it is our belief that such action should be taken by Congress or departmental heads to bring about the above and that in such consolidation, no laws should be enacted which will limit or restrict the lawful powers of the state.

Resolved, That this Association is in sympathy with the movement to create a general Wildlife Federation and will, within the states constituting the Association, lend its support to the federating of the various groups interested in wildlife—its restoration and perpetuation.

Resolved, That this Association recommend to the United States Senate Committee on Conservation of Wildlife Resources and the similar committee in the House of Representatives that they investigate the possibility and desirability of a federal aid program for wildlife restoration throughout the nation, state by state, similar in plan to that which is practiced by the federal government through its Public Roads Bureau in the building of the national highway system, with the thought in mind of restoring the habitat for game on all public lands, both state and federal.

Resolved, That the Western Association favor 60-day open season on waterfowl, shooting days not more than three days per week, two of which must be consecutive.

Resolved, That this Association reiterate its stand taken at Santa Fe in 1935, relative to the Taylor Grazing Act.

WHEREAS, The Indian Irrigation Service has, during the past 15 years, developed a very satisfactory irrigation system which has made possible profitable utilization of farm lands upon Indian reservations; and

WHEREAS, Through the development of this system has resulted the loss of great numbers of game fish which would otherwise be available to the Indian; and

WHEREAS, In many cases development of the irrigation system has benefited the Indians to but a small extent due to the control of irrigable lands having passed from the Indians to the Whites, but has taken from the Indians the very resources intended in treaties that should be reserved to them, that of the game fish; therefore be it

Resolved, That the Western Association of Game and Fish Commissioners at the 16th annual meeting in San Francisco, July 22d and 23d, 1936, go on record as favoring a program which would require all irrigation ditches under the administration of the Indian Irrigation Service be properly screened to preserve loss of game and food fish in order that the recreational and economic resources shall be properly protected.

WHEREAS, Each state fish and game commission in the western states in addition to the federal Bureau of Fisheries each year spends many thousand dollars upon propagation and distribution of game fish; and

WHEREAS, Many of the potential game fish waters are to be found in the upper reaches of streams, the water of which is ultimately used for irrigation purposes by the U. S. Bureau of Reclamation; and

WHEREAS, The fish and game commissions are without means to assume the responsibility for screening diversion ditches and are endeavoring to have the responsibility for screening diversion ditches assumed by the individual water user which is an impossibility under the present lack of this responsibility by governmental bureaus administering reclamation and irrigation projects; therefore be it

Resolved, That, at the 16th annual meeting of the Western Association of Game and Fish Commissioners at San Francisco, California, July 22d and 23d, 1936, this Association go on record as being opposed to further delay by the Reclamation Service in correcting this condition and every effort be made to the end that all diversion ditches under jurisdiction of the U. S. Bureau of Reclamation be properly screened to prevent loss of fish life.

WHEREAS, Since this Association assembled, the newspapers have carried stories intimating irregularities in the expense account of Mr. Herbert C. Davis, Executive Officer of the California Fish and Game Commission; therefore be it

Resolved, That this Association express its appreciation for the splendid service rendered by him and its confidence in his honesty and integrity, and that we unanimously express our wholehearted confidence in his honesty and integrity and believe that an investigation will conclusively establish his innocence of the charges that have been made against him.

Resolved, That this Association express its appreciation to the State of California and the following individuals and organizations for their part in this most successful convention: the California Fish and Game Commission and their employees; Mayor of San Francisco; Management of the Alexander Hamilton Hotel; San Francisco Con-

vention Bureau; Organized Sportsmen of California; the California Academy of Sciences; the press of San Francisco and Oakland and those who have taken part on this program.

WHEREAS, During his incumbency as president of this Association for two terms, the western states have faced many of the most crucial problems affecting the wildlife, progress toward solution of which is the result of his able leadership, broad, sympathetic interest and executive ability, we do hereby extend to Elliott S. Barker this expression of our appreciation of his work as an officer and a man.

CALIFORNIA FISH AND GAME

A publication devoted to the conservation of wild life and published quarterly by the California Division of Fish and Game.

VOLUME 23 JANUARY, 1937 No. 1

The State of California feels definitely privileged to have been the host to the Western Association of State Game and Fish Commissioners on July 22 and 23, 1936, when they convened at San Francisco, California, for their 16th annual convention.

The entire proceedings were so methodically handled, so businesslike in every respect and produced such splendid papers by competent authorities on fish and game matters it was felt that the proceedings and opinions of leaders in conservation from other states and from the federal government would be of value and benefit to the people of the State of California.

We are therefore printing the transactions as an issue of CALIFORNIA FISH AND GAME in order that the record may be preserved and made available to the people of this State.—*Herbert C. Davis.*

REPORTS

STATEMENT OF REVENUE

For the Period July 1, 1936, to September 30, 1936, of the Eighty-eighth Fiscal Year

REVENUE FOR FISH AND GAME PRESERVATION FUND

Current year—		
License sales:		
Angling licenses, 1936	$112,582 00	
Commercial hunting club licenses, 1936-1937	75 00	
Commercial hunting club operators licenses, 1936-1937	10 00	
Deer tags, 1936	27,685 00	
Fish breeders' licenses, 1936	20 00	
Fishing party vessel permit, 1936	49 00	
Fish packers and wholesale shellfish dealers licenses, 1936 and 1937	705 00	
Game breeders' licenses, 1936	80 00	
Hunting licenses, 1935-1936	19,851 00	
Hunting licenses, 1936-1937	72,907 00	
Market fishermen's licenses, 1936-1937	30,640 00	
Trapping licenses, 1936-1937	64 00	
Total license sales		$264,668 00
Other income:		
Court fines	$19,139 96	
Fish packers' tax	32,700 23	
Fish tag sales	616 04	
Game tag sales	56 25	
Interest on bank balances	1,464 98	
Kelp tax	33 45	
Lease of kelp beds	283 60	
Publication sales	66 85	
Salmon tax (Chap. 1015-35)	4,928 18	
Miscellaneous sales	1,301 58	
Total other income		60,591 12
Grand total		$325,259 12

STATEMENT OF EXPENDITURES

For the Period July 1, 1936, to September 30, 1936, of the Eighty-eighth Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Operating expenditures eighty-eighth fiscal year					
Administration:					
Executive	$1,249 98			----------	$1,249 98
General office	1,380 00	$296 86	$122 09	----------	1,798 95
Printing, general		146 92	----------	----------	146 92
Automobiles		34 14	16 51	----------	50 65
Traveling			677 46	----------	677 46
Postage			1,229 71	----------	1,229 71
Telephone and telegraph			369 74	----------	369 74
Freight, cartage and express			193 75	----------	193 75
Rent			2,004 34	----------	2,004 34
Accident and death claims			895 33	----------	895 33
Departmental Administration pro rata	2,500 00			----------	2,500 00
Librarian	450 00	6 39	19 00	$22 85	498 24
Legal	----------	----------	22 50	----------	22 50
Sales tax on sales, deducted from total	----------	----------	—1 17	----------	—1 17
Total Administration	$5,579 98	$484 31	$5,549 26	$22 85	$11,636 40
Patrol and Law Enforcement:					
Chief and assistants	$3,555 00		----------	----------	$3,555 00
General office	1,365 00	$15 58		$4 04	1,384 62
Automobiles	----------	4,402 00	$2,129 21	5,950 28	12,481 49
Traveling	----------	----------	11,868 38	----------	11,868 38
Postage	----------	----------	183 86	----------	183 86
Telephone and telegraph	----------	----------	349 00	----------	349 00
Rent		----------	201 48	----------	201 48
Captains and wardens	51,575 03	97 13	157 26	----------	51,829 42
Launches	2,200 20	2,241 15	1,813 64	138 41	6,393 40
Temporary help	350 81	----------	----------	----------	350 81
Assistant fish and game wardens, seasonal	3,102 30	----------	----------	----------	3,102 30
Total Patrol and Law Enforcement	$62,148 34	$6,755 86	$16,702 83	$6,092 73	$91,699 76
Commercial Fisheries:					
Chief and assistant	$2,610 00	----------	----------	----------	$2,610 00
General office	2,346 77	$23 97	$3 50	$119 13	2,493 37
Automobiles	----------	34 69	57 01	623 15	714 85
Travel	----------	----------	1,568 60	----------	1,568 60
Telephone and telegraph	----------	----------	234 27	----------	234 27
Freight, cartage and express	----------	----------	18 39	----------	18 39
Rent	----------	----------	44 36	----------	44 36
Heat, light, water and power	----------	----------	67 41	----------	67 41
Research (oyster)	570 00	7 52	----------	----------	577 52
Laboratory	6,972 42	332 28	124 84	374 86	7,804 40
Cooperative research	----------	----------	250 00	----------	250 00
Statistics	----------	64 28	519 00	----------	583 28
Temporary help	300 00	----------	----------	----------	300 00
Terminal Island grounds	150 00	----------	----------	----------	150 00
Fish cannery auditing	----------	----------	530 00	----------	530 00
Total Commercial Fisheries	$12,949 19	$462 74	$3,417 38	$1,117 14	$17,946 45
Fish Conservation:					
Chief and assistants	$1,815 00	----------	----------	----------	$1,815 00
General office	1,320 00	$1 73	$2 15	----------	1,323 88
Automobiles	----------	2,456 86	661 62	$6 56	3,125 04
Traveling	----------	----------	3,043 30	----------	3,043 30
Postage	----------	----------	39 19	----------	39 19
Telephone and telegraph	----------	----------	241 38	----------	241 38
Freight, cartage and express	----------	----------	25 60	----------	25 60
Rent	----------	----------	149 00	----------	149 00
Heat, light, water and power	----------	----------	314 29	----------	314 29
Fish planting	----------	502 02	743 00	14 30	1,259 32
Hatcheries	27,300 00	11,268 43	211 20	312 57	39,092 20
Fish cars	450 00	----------	722 73	----------	1,172 73
Cooperative research	780 00	47 43	8 18	11 33	846 94
Statistical	216 78	77	243 70	----------	461 25
Temporary help	224 51	----------	----------	----------	224 51
Special field	3,390 00	2 57	----------	----------	3,392 57
Fish rescue	480 00	----------	25 50	----------	505 50
Assistant fish and game wardens, seasonal	10,365 61	----------	----------	----------	10,365 61
Total Fish Conservation	$46,341 90	$14,279 81	$6,430 84	$344 76	$67,397 31

STATEMENT OF EXPENDITURES

For the Period July 1, 1936, to September 30, 1936, of the Eighty-eighth Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Hydraulics:					
Chief and assistants	$1,816 30				$1,816 30
General office	480 00	$10 63	$2 88		493 51
Automobiles		60 82	16 17	$10 97	87 96
Traveling			620 87		620 87
Total Hydraulics	$2,296 30	$71 45	$639 92	$10 97	$3,018 64
Game Conservation:					
Chief and assistants	$3,264 99				$3,264 99
General office	1,170 00	$2 88	$1 50		1,174 38
Automobiles		579 02	123 41	$437 65	1,140 08
Traveling			919 91		919 91
Telephone and telegraph			68 05		68 05
Freight, cartage and express			31 29		31 29
Heat, light, water and power			1,209 87		1,209 87
Maintenance of game farms	2,946 97	4,259 01	88 36	496 90	7,791 24
Predatory animal control (to be corrected)	370 00				370 00
Statistics		1 22	247 77		248 99
Temporary help	1,797 63				1,797 63
Maintenance of game refuges	1,808 00	71 33	29 27		1,908 60
Total Game Conservation	$11,357 59	$4,913 46	$2,719 43	$934 55	$19,925 03
Licenses:					
General office	$3,465 00	$3 61	$78 76	$2 16	$3,549 53
Printing licenses and applications		302 85	152 05		454 90
Postage			398 10		398 10
Freight, cartage and express			4 86		4 86
Premiums on bonds			861 65		861 65
Identification license buttons		1,954 53	14,885 45		16,839 98
Total Licenses	$3,465 00	$2,260 99	$16,380 87	$2 16	$22,109 02
Special item:					
State fair and other exhibits (payable from Support, Chapter 341-35, or E. O. for Support)	$40 00		$1,200 00		$1,240 00
Total special item	$40 00		$1,200 00		$1,240 00
Total 88th fiscal year, expense paid from support appropriations	$144,178 30	$29,228 62	$53,040 53	$8,525 16	$234,972 61
Prior year, 87th fiscal year support					11,497 98
Total 87th and 88th fiscal year for Support					$246,470 59
Special items:					
Predatory Animal Control:					
88th fiscal year:					
Chief and assistants	$975 00				$975 00
General office	240 00			$25 00	265 00
Automobiles		$297 04	$77 54		374 58
Traveling			526 20		526 20
Predatory animal control	3,654 67		1,155 59		4,810 26
Predatory animal hunters and trappers, seasonal	1,500 00				1,500 00
Total 88th fiscal year	$6,369 67	$297 04	$1,759 33	$25 00	$8,451 04
87th fiscal year					38 25
Total Predatory Animal Control, 87th and 88th fiscal years					$8,489 29
Total operating expenditures, 87th and 88th fiscal years					$254,959 88
Expenditures for additions and betterments:					
Permanent improvements:					
Purchase of game refuges and public shooting grounds and construction, improvements and equipment (Chapter 341-35)	$6,771 73	$6,161 78	$3,587 41	$491 89	$17,012 81
Prior year: 87th fiscal year construction, improvements and equipment and purchase of game refuges and public shooting grounds (Chapter 341-35, all objects)					$1,887 00
Total permanent improvements, 87th and 88th fiscal years					$18,899 81
Grand total					$273,859 69

SEIZURES OF FISH AND GAME

July, August, September, 1936

Game:	
Bear	1
Deer	31
Deer head	2
Deer hide	1
Deer meat, pounds	525
Doves	607
Duck	7
Meadowlark	2
Pheasants	30
Quail	57
Rabbits	60
Woodpecker	3
Fish:	
Abalone	68
Barracuda	125
Barracuda, pounds	200
Bass—	
Black	54
Rock	4
Sea, pounds	39
Striped	172
Catfish, pounds	70
Clams	1,519
Crab	136
Crappie	11
Croaker	1
Lobsters	78
Lobsters, pounds	55
Perch	31
Salmon	14
Sunfish	42
Traps	10
Trout	673
Tuna, pounds	6,421
Yellowtail	1

GAME CASES

July, August, September, 1936

Offense	Number arrests	Fines imposed	Jail sentences (days)
Deer; closed season; kill and possess spotted fawn, spike buck, doe; fail to tag deer; transferring tags	146	$4,467 50	422½
Dove; closed season; overlimit	47	1,680 00	
Ducks; closed season	6	350 00	
Firearms in refuge	22	415 00	52
Game birds; closed season	6	85 00	
Hunting; no license; in refuge; closed area	82	1,370 00	47½
Illegal shooting	21	315 00	1
License; using another's; false statement	7	75 00	
Night hunting	5	50 00	
Non-game birds in possession	6	110 00	
Pheasant; closed season	20	850 00	
Quail; closed season; overlimit	17	710 00	45
Rabbits; closed season	23	400 00	
Sierra hare in possession	1	50 00	
Spotlighting	19	1,000 00	
Trapping; no license	1		
Totals	429	$11,927 50	568

FISH CASES

July, August, September, 1936

Offense	Number arrests	Fines imposed	Jail sentences (days)
Abalone; overlimit; undersize	17	$280 00	25
Angling; no license	93	659 00	
Barracuda; overlimit; possession and sale of undersize	3	115 00	
Bass, black; overlimit; undersize	11	153 00	22
Bass, sea; overlimit; undersize	4	370 00	
Bass, striped; overlimit; undersize	26	605 00	55
Clams; closed season; overlimit; undersize; instrument in preserve	54	785 00	210
Commercial fishing; no license	77	445 00	5
Crabs; possession female; undersize; closed season	22	390 00	5
Fishing; closed district; closed season; from fishway; too near dam; using prohibited gear	59	2,310 00	15
Fishing boat not registered	1	25 00	
Fish wastage	3	100 00	
License; using another's; making false statement	12	130 00	35
Lobsters; closed season	7	60 00	
Net; illegal	25	995 00	
Night fishing	15	160 00	
Perch; selling closed season	3	75 00	
Pollution	8	415 00	
Salmon; overlimit; undersize	7	150 00	
Sardines; exceeding sardine permit tonnage allotment	4	1,500 00	
Sunfish; closed season	2	15 00	
Trout; overlimit	14	383 00	
Totals	467	$10,120 00	372

CALIFORNIA FRESH FISH LANDINGS* FOR JULY, AUGUST AND SEPTEMBER, 1936

Compiled by the Division of Fish and Game, Bureau of Commercial Fisheries

Species	Region 10, Del Norte	Region 20, Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds
Anchovy				90,150	22,460		4,511		117,121
Barracuda						32,278	153,279	549,148	734,705
Cabezone				2,500	3,040	235	10		5,785
Cabrilla							2,125	5,566	7,691
Carp			3,586						3,586
Catfish			66,175						66,175
Cultus, Pacific	2,162	22,155		118,829	34,812	62			178,320
Dolphin							92		92
Eel				42					42
Flounder, Starry	32	37		158,020	527				158,616
Flying Fish							28,680		28,680
Grouper							990		990
Hake				18,130					18,130
Halibut, California				3,352	5,905	91,957	16,590	300,395	418,199
Halibut, Northern	1,022	74,695		5,122					80,839
Hardhead			2,700						2,700
Herring, Pacific					500	136			636
Kingfish				3,651	12,230	90	82,867	233	129,071
Mackerel, Horse					19,346		1,853,687	1,200	1,874,233
Mackerel, Pacific		464		27,211	1,739,800	6,491	10,535,798	6,468,359	18,778,123
Mullet							1,912	323	2,235
Perch				18,615	4,881	2,942	17,769		44,207
Pike			3						3
Pompano, California					14		3,972	467	4,453
Rock Bass					8	8,306	72,664	103,085	184,063
Rockfish	7,329	24,863		150,604	762,485	96,174	27,615	51,816	1,120,886
Sablefish	291	188,894		33,180	16,333	520	19,725		288,943
Salmon	109,295	2,612,648	531,314	285,989	26,260	270	750		3,596,556
Sand Dab				142,625	4,578		1,074		148,277
Sardine			35,385,950	19,821,800	113,827,817	1,386	29,390	577	169,069,920
Sculpin					80	19	28,539	96	28,734
Sea-bass, Black							82,075	12,262	94,337
Sea-bass, White				4,082	6,217	17,357	20,943	174,298	222,897
Shark				13,389	111	4,473	58,077	2,549	78,599
Sheepshead						17	6,875	1,435	8,327
Skate				53,863	2,428	635	940	664	58,530
Smelt	177	3,241		91,287	54,752	5,951	54,669	1,656	211,733
Sole	1,070	393		2,088,156	11,093	50,302	647		2,154,661
Split-tail			400						400
Swordfish, Broadbill						43,887	345,788	107,115	496,790
Swordfish, Marlin							14,572	1,908	16,480
Tomcod				2,645					2,645

Tuna, Albacore					19,505	1,592	1,116,977	2,336	1,140,410
Tuna, Bluefin					22	3,642	7,435,790	960,460	8,399,914
Tuna, Bonito					17		3,704,560	861,978	4,569,555
Tuna, Oriental							595,074		595,074
Tuna, Skipjack							5,050,189	8,215,724	13,265,913
Tuna, Yellowfin						35	5,133,576	15,281,591	20,415,202
Turbot				32,119	100		30		32,249
Whitebait	507	23,053		4,365	87				28,012
Whitefish							262	1,902	2,164
Yellowtail						46	1,463,328	3,674,931	5,138,305
Miscellaneous Fish		1,338	10	39,282	34	1,716	588	365	43,333
Crustacean:									
Crab	6,260	62,001		146,230	18				214,512
Crab, Rock							2,414		2,414
Prawn					301				301
Shrimp				1,325,318					1,325,318
Mollusk:									
Abalone				2,600	604,675	620,740	150		1,228,165
Clam, Cockle				295			5,535		5,830
Clam, Gaper				1,130					1,130
Clam, Pismo					2,551	66,765			69,316
Clam, Soft-shell				19,209					19,209
Clam, Washington		5,385		839					6,077
Octopus				1,093	14,337		34	19	15,483
Oyster, Eastern				55,356					55,356
Oyster, Japanese				94,696	1,975				96,671
Oyster, Native				3,430					3,430
Squid				1,075	49,655		26		50,756
Reptile:									
Turtle							475	1,617	2,092
Total pounds	128,145	3,049,323	35,990,168	24,863,579	120,311,954	1,058,024	68,305,333	33,487,075	287,193,601

* Importations of fresh fish from foreign countries included. See foreign importation tables.

FRESH FISH IMPORTATIONS* FROM FOREIGN COUNTRIES FOR JULY, AUGUST AND SEPTEMBER, 1936

Compiled by the Division of Fish and Game, Bureau of Commercial Fisheries

Species	Landed in Region 70, Los Angeles	Landed in Region 80, San Diego	Total pounds
Barracuda	7,756	193,147	200,903
Cabrilla	2,125	5,566	7,691
Grouper	990		990
Halibut, California		299,926	299,926
Kingfish		166	166
Mackerel, Horse		1,200	1,200
Mackerel, Pacific		1,601,605	1,601,605
Pompano, California		402	402
Rock Bass	435	26,482	26,917
Rockfish		20,381	20,381
Sardine		482	482
Sea-bass, Black	77,170	12,103	89,273
Sea-bass, White	788	169,218	170,006
Shark		1,245	1,245
Sheepshead		1,038	1,038
Skate		555	555
Smelt		424	424
Swordfish, Broadbill	1,518	20,958	22,476
Swordfish, Marlin		292	292
Tuna, Albacore	358,784		358,784
Tuna, Bluefin	454,676	864,174	1,318,850
Tuna, Bonito	3,521,372	672,683	4,197,055
Tuna, Oriental	595,074		595,074
Tuna, Skipjack	1,256,318	5,080,342	6,336,660
Tuna, Yellowfin	4,552,326	15,182,628	19,734,954
Whitefish		1,452	1,452
Yellowtail	1,442,533	3,638,617	5,081,150
Miscellaneous Fish		365	365
Reptile:			
Turtle		1,617	1,617
Total pounds	12,274,865	27,797,068	40,071,933

* These importations are included in tables of landings. They include fish caught by California boats in foreign waters as well as frozen fish imported for canning in California plants.

FRESH FISH IMPORTATIONS BY POINT OF ORIGIN* FOR JULY, AUGUST AND SEPTEMBER, 1936

Compiled by the Division of Fish and Game, Bureau of Commercial Fisheries

Species	Gulf of California	West Coast Lower California	International waters south U. S. boundary (definite origin unknown)	Mexican mainland, Central and South America	Japan	Total pounds
Barracuda		198,714	2,189			200,903
Cabrilla		2,125	5,566			7,691
Grouper		990				990
Halibut, California		299,926				299,926
Kingfish		166				166
Mackerel, Horse		1,200				1,200
Mackerel, Pacific		1,601,605				1,601,605
Pompano, California		402				402
Rock Bass		26,917				26,917
Rockfish		20,381				20,381
Sardine		482				482
Sea-bass, Black		88,263	1,010			89,273
Sea-bass, White		170,006				170,006
Shark		1,245				1,245
Sheepshead		1,038				1,038
Skate		555				555
Smelt		424				424
Swordfish, Broadbill		22,476				22,476
Swordfish, Marlin		292				292
Tuna, Albacore					358,784	358,784
Tuna, Bluefin		1,257,602	61,248			1,318,850
Tuna, Bonito		3,581,254	615,801			4,197,055
Tuna, Oriental					595,074	595,074
Tuna, Skipjack	37,663	2,147,252	3,605,837	8,895	537,013	6,336,660
Tuna, Yellowfin	576,859	2,209,314	15,357,007	1,583,146	8,628	19,734,954
Whitefish		1,452				1,452
Yellowtail		4,956,361	124,789			5,081,150
Miscellaneous Fish		365				365
Reptile:						
Turtle		1,617				1,617
Total pounds	614,522	16,592,424	19,773,447	1,592,041	1,499,499	40,071,933

* These importations are included in tables of landings. They include fish caught by California boats in foreign waters as well as frozen fish imported for canning in California plants.

38512 4-37 2700

O

California Fish and Game

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

VOLUME 23 SAN FRANCISCO, APRIL, 1937 Number 2

TABLE OF CONTENTS

CALIFORNIA FISH AND GAME is a publication devoted to the conservation of wildlife. It is published quarterly by the California Division of Fish and Game. All material for publication should be sent to Richard S. Croker, editor, California State Fisheries Laboratory, Terminal Island, California.

43375

ELEVEN YEARS OF PROGRESS AT THE CALIFORNIA STATE GAME FARMS[1]

By AUGUST BADE
Superintendent, State Game Farms
California Division of Fish and Game

Eleven years ago the average upland game bird hunter of California knew very little about the sport of pheasant shooting. What little was known then came from men who had visited in either Oregon or Washington or moved to California from there. At that time upland shooting was confined to quail and doves. The great expanse of thousands of acres in the Sacramento and San Joaquin valleys lay as waste lands as far as the hunter was concerned, with the exception of a few weeks in the late fall when duck and goose shooting offered a little sport if one were lucky enough to belong to a club.

During the past three years the sportsmen of California have become acquainted with pheasant shooting in every detail and now each year during the open season, thousands of men, and women, too, find great pleasure in pursuing the wily pheasant.

All of this has come about because eleven years ago actual construction work was begun in building the Yountville State Game Farm. Four years later a second farm was constructed in the south at Chino in San Bernardino County. Each of these farms has a definite area to serve. The Yountville farm takes care of the area north of Bakersfield whereas the Chino farm looks after all the country to the south.

The game farms of California are manned by a competent personnel of Civil Service employees that gives the work stability and keeps it free from unfavorable influence and dominance. And, since all game farm activities are financed from the sale of hunting licenses, these farms are owned by the sportsmen of this State and are being operated for their pleasure and benefit. Inasmuch as these farms are owned by the sportsmen of California it would seem good business, on the part of the sportsmen, to protect and in every way look after the welfare of these birds when they are released in the field and covers of the State to reproduce according to their own choosing.

The methods of production, distribution, and the selection of particular kinds of game birds to be produced and planted, are all worked out with the idea of meeting California conditions as they exist today. These three phases of our game farm program are discussed on the following pages.

Various Types Produced

With the working out of a better method of production and distribution, California game farms have gone a step further and made

[1] Submitted for publication, March, 1937.

an effort to select a type of bird that was suited in every way to the particular territory to be restocked. In view of these facts and conditions only certain game birds are found fully equipped in every way to qualify on this program. First of all any game bird that stands a chance of making good today must be smart. In checking over the list that experience has approved, we find the following birds qualify: At the head of this list of smart game birds we will place the California valley quail, the ringneck and Mongolian pheasant come next, the Reeves and chukar partridge are a good third, with the Mexican bronze turkey fourth. Ability to reproduce under domestic conditions as well as field and table qualities are taken into account in making this selection.

California valley quail and pheasants are produced on our game farms in about equal proportions. In proof of this statement the records for 1936 show that 21,587 pheasants and 19,843 quail were liberated during the season. Since the game farms were established and a definite program of production and distribution inaugurated on December 7, 1925, these farms have produced and distributed a total of 204,456 game birds. In addition to the native quail, the introduced species described below are propagated at the California game farms.

Ringneck Pheasant.

First in this list of introduced birds comes the ringneck pheasant. This bird is well suited to the valleys and agricultural districts but does not do well in the mountains or timbered areas. As a field and table bird he has few equals and the fact that he can be reared under domestic conditions very successfully gives him first place on any game farm program.

Mongolian Pheasant.

The Mongolian pheasant, often confused with the ringneck because of the white ring on his neck and general similarity in color and build, is a bird that is better suited to the brush and timbered areas.

Reeves Pheasant.

To supplement the blue grouse, it was deemed necessary to find a bird that would fit into the picture of our higher altitudes. The Reeves pheasant, one of the most beautiful of birds as well as the fastest pheasant on the wing, was selected as the successor to the blue grouse. This bird seldom lives in altitudes lower than 2000 feet. Its natural home is in altitudes ranging from 2000 feet up to 8000. The fact that it roosts off the ground is another factor in its favor.

Wild Turkeys.

At the present time, 17 of the 48 states have an open season on turkeys. This would indicate that the turkey as a game bird is very much in the picture today and not just a relic of the good old days of Daniel Boone and William Penn. California has many thousands of acres well suited to the Mexican bronze turkey, so that is the one being propagated for stocking purposes in this State. In this connection it might be well to remember that four distinct types of turkeys are found in the United States and that they are all wild and indigenous to this

continent. The Mexican bronze is the largest of the four and was the one that was selected for domestication. Foundation stock for California game farms comes from Carlsbad, New Mexico.

Chukar Partridge.

The chukar partridge fits into our scheme of restocking because it naturally lives in barren and desolate regions. In India, its native home, it is known as "the bird that lives on nothing." In other parts of the old world, it is called the "air" partridge for the same reason. If you carefully consider the State of California for a moment you will easily come to the conclusion that we have plenty of room for this game bird. The Chukar partridge meets with the approval of sports-

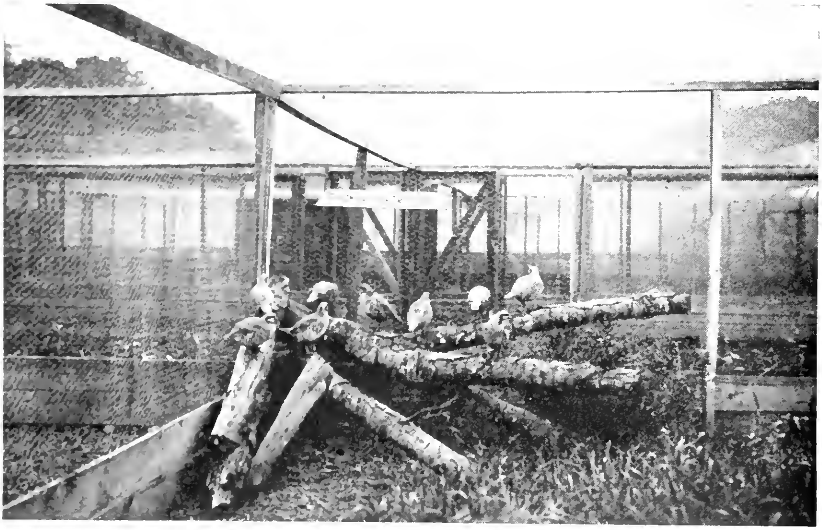

FIG. 1. Adult chukar partridge in holding pen at Yountville State Game Farm. Photograph by author.

men because it is a fine game bird and the best table bird of all the feathered tribe.

So far about 4500 of these birds have been propagated on our game farms and planted in about eighty different sections of the State. The plantings include all types of country from almost sea level to elevations of four or five thousand feet. In general the Sierra range of mountains has been chosen as their home, although many other localities have been included in the initial experiments to find out as soon as possible just where this bird will do the best.

Chukars have reproduced on the floor of the San Joaquin Valley, in Kings Canyon, Mojave Desert, Siskiyou County, and in the desert sections of Kern County. In most cases they have shown a preference for the higher regions where, at the present time, we have no other game bird. As they have been checked as high as 14,000 feet, it looks as though California sportsmen will soon be able to go out into real wide open spaces and still have companionship with a real game bird. These birds are slate grey in color with red legs and bill. They have

black stripes along their sides as well as a black necktie. This color scheme gives them a camouflage that makes them hard to see in any kind of cover. They are about three and one-half times larger than our native valley quail and are faster in flight.

As game farm birds they have already proved their worth as producers. The records of three different hens credit them with the laying of 106, 112, and 136 eggs, respectively, for a single season.

System of Artificial Incubation and Brooding

For a great many years all types of game birds were reared with the domestic hen as a foster mother. In fact the old reliable domestic hen became the foundation of game bird reproduction. As years passed by and game bird farming became more of a business, it was found that a great many of the domestic poultry diseases were introduced through the agency of the hen to whatever type of game bird was being reared.

Among the more common pathological diseases were tuberculosis, coccidiosis and black head, as well as several different types of intestinal worms.

The factors of disease entered into the business of rearing game birds to such an extent that it was found necessary to devise ways and means of overcoming the disease hazard. It was found that the artificial incubator and brooder met this condition in a most efficient manner, and the more we delve into the interesting subject of artificial incubation and brooding and become familiar with its possibilities, the more we are convinced that the system has come to stay and that game birds of the future will be produced via the incubator and brooder.

There is nothing strange or mysterious about this system. It has been in use since the time of the Egyptians. History proves this statement. Even today the Chinese use primitive methods with good results. One traveler related this interesting story to the writer: While visiting in the Hawaiian Islands he saw three Chinese taking off a hatch of ducks that numbered 14,000. For incubators they used holes dug in the bank of a rice paddy, and common manure furnished the heat. Each hole or incubator contained about 100 eggs and about 90 per cent of the eggs produced ducklings.

Surely if a person can get results with such crude equipment, we ought to do fairly well with what modern engineering has given us in the way of positive sanitary equipment.

The artificial incubator and brooder is to modern game farming what improved methods of production are to industry. The manufacturer is constantly considering ways and means of lowering production costs. Better equipment plus an experienced personnel is the largest factor in increasing production and lowering costs. Clean and healthy working conditions add to the efficiency of workers. Good food and clean sanitary quarters produce better game birds. The modern artificial brooder, where all conditions are under control, is the game breeders' best friend.

The principal claim that we make for artificial methods is this: More and better birds are produced with the same or even less effort. The money invested in equipment, on account of its long life, makes

the capital investment of greater value because of its small depreciation each year. The average life of this equipment is not less than twenty years.

Here is a good example of what we mean in comparing the old method with our present set-up for producing game birds. In 1928 and 1929 we employed 12 men and the production was a little more

FIG. 2. Some of the electric brooder houses at the Yountville State Game Farm. Photograph by author, May, 1936.

than 6000 birds each year. In 1935 with the number of men reduced to 8 and artificial methods used exclusively, the output of birds was 19,789, and they were all disease-free, healthy, strong birds.

In 1928 and 1929 we spent, on the average, the sum of $1,800 for setting hens alone, to say nothing of the cost of picking them up from the farmers that lived within a radius of 20 miles of the farm. At the end of the season these hens were put on the market and brought less than $600. Our outlay then for incubating and brooding was at least $1200 each year or about 20 cents per bird, which does not include the cost of the eggs nor feed for the chicks and hens.

This incubating and brooding cost would not have been such an item if it had not been for the fact that we were producing a lot of diseased birds and fouling the ground upon which future birds would be reared.

As our brooder houses are arranged with 10 rooms to the house, it is easy to check the cost of production by placing a meter on the house to be checked and weighing the feed that the birds consume during the brooding period of 30 days. As these houses accommodate not less than 1000 birds, the check is on a sufficient number to make it authentic. Inasmuch as we know the cost of electric current and the price of feed, the cost of the building, the man hours required to care for the birds, the amount that should be deducted for depreciation on equipment (5 per cent annually) and the price of labor, a fairly accurate production cost sheet can be had.

The cost of these 10-room brooder houses, full concrete foundation for both house and run, is \$900. If a depreciation of 5 per cent or \$45 is taken, that amount is added to the cost of brooding for the year. And, since each house takes care of three lots of birds for the season, a charge of \$15 for depreciation is made against each brooding period.

The incubating and brooding cost of a 30-day-old chick is 12 cents. (See table 1.) To make the story complete we will add the cost of the egg that produces the chick. From our records we find that it takes, on the average, two eggs to produce one good chick. These eggs are valued at eight cents each. From these figures you will see that when the chick is ready for the holding pen it has cost 28 cents.

According to figures turned in to us from several different rearing pen projects where several thousand birds were handled during the season. and a paid attendant was employed, the cost per bird, for this further developing period of six to seven weeks, is 24 cents.

The following tables give the cost details on incubating and brooding chicks to the age of 30 days at the Yountville Game Farm in 1935:

TABLE 1

Cost of Thirty-Day-Old Chicks Brooded in Lots of 1000, with a 90 Per Cent Survival

Labor, 96 hrs., @ \$0.50	\$48 00
Power, 2450 K.W.H.	26 00
Depreciation on equipment	15 00
Feed	19 29
Total	\$108 29

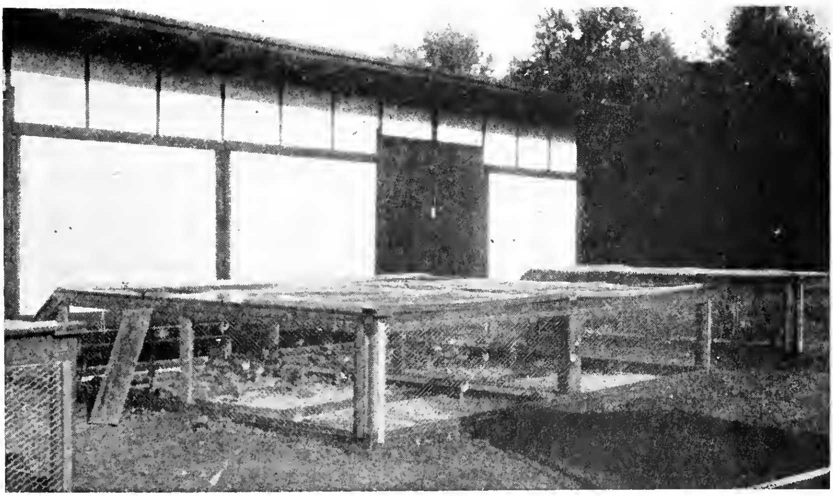

FIG. 3. Electric brooder with week-old pheasant chicks. Photograph by author, Yountsville State Game Farm.

In the foregoing table, the labor item covers all work of incubating, hatching and brooding. The power item covers all the electricity used in these processes. Power costs for artificial incubation will vary with the cost of electricity in the particular localities concerned, and with

the amount of power used for all purposes, as the rate per kilowatt hour decreases as more power is consumed. Power consumption at Yountville is considerable, so the rate is relatively low. Feed costs, which are presented in detail in table 2, apply to the entire lot of chicks which numbered 1000 at the start and 900 at the end of the brooding period of 21 to 30 days.

TABLE 2

Amount of Feed and Cost for 1000 Chicks

Game meal, No. 12, 55 lbs., @ $8.60 cwt.	$4 74
Game meal, No. 5, 27 lbs., @ $8.60 cwt.	2 32
Game chick grain, 36 lbs., @ $2.80 cwt.	1 10
Rolled hulled barley, 10 lbs., @ $1.10 cwt.	0 11
Buckwheat grain, 12 lbs., @ $3.50 cwt.	0 42
Semisolid buttermilk, 12 lbs., @ $3.50 cwt.	0 42
Hard-boiled eggs, 18 doz., @ $2.75 case	1 38
Chick growing mash, 400 lbs., @ $2.20 cwt.	8 80
Total	$19 29

System of Distribution

It is one thing to produce fine, healthy game birds but quite a different matter to get them properly distributed and released into covers where they will get at least a running start in life and have an equal chance to survive and multiply according to their natural inclinations.

In the past decade or two many schemes have been tried in the production and distribution of game birds. Out of this experience two factors seem to stand out in bold relief. The first is that clean, healthy stock must be produced. The disease hazard must be cut to the very minimum. This means the elimination of the domestic hen as a foster mother. Her place must be taken by the incubator and brooder. In many states and localities where the leadership in this particular industry is a little more far seeing, this forward step has already been taken and the artificial incubator and brooder is already considered permanent game farm equipment.

After these birds have been reared to an age when they are ready to be placed in the covers, the second factor that has become apparent out of this experience presents itself. It is obvious that very definite safeguards must be placed around these birds during the first three or four months of life in the open. This brings us to the idea of the closed area or refuge where no hunting of any kind is allowed and where the birds' natural enemies are held in control. When this closed area idea was first advanced, many held to the idea that it would be impossible to secure the necessary ground for this sanctuary. Experience, however, has proven that about 90 per cent of all land owners are more than willing to have their land included in a closed area. In many cases it has been found possible to secure ideal conditions with ample food, water and cover by the combining or pooling of several holdings. The land owner in this case is not only in partnership with the State but has also become a protector in that he is interested in seeing that the birds that have been liberated on his particular ground have the utmost protection.

With the development of this closed area idea has grown up another factor that has proven its worth many times over. Many sportsmen's clubs as well as individuals have become interested to the point that they have been willing to build holding pens for the development of birds up to the point where they are old enough for liberation. In many cases these pens are built on the ground that is being stocked, so that all that is necessary when the time for liberation arrives is to open the gates of the pens, letting the birds walk out and start their period of readjustment unmolested.

In other instances, units of these pens have been sponsored and built by sportsmen's organizations for the rearing and development of birds to be planted in their immediate vicinity. In this case these birds are taken from the rearing pens in crates and transported to the particular ground to be stocked. In California this program has grown

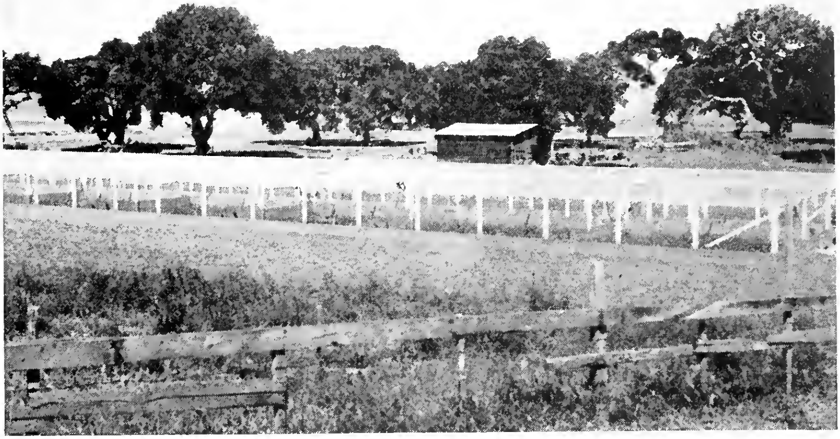

FIG. 4. The Salinas Rod and Gun Club unit of 20 holding pens, Monterey County, California. Photograph by author, July, 1935.

and developed since the building of 12 pens at Cotati, Sonoma County, in 1932, to a system and net-work of pens that now numbers over 1000.

To show more clearly and definitely just what this holding pen idea means, Bakersfield in Kern County can be used as an example. Before any holding pens were built in Kern County we were never able to liberate more than 300 birds in that county during the season. During the first year's operation of 20 holding pens, 1200 birds were liberated, and during the second year when 10 more pens were added to their unit, making 30 in all, 1800 birds were liberated. During the 1935 season, 2017 pheasants, quail and partridges were handled through these pens. In 1936 the number was 2770.

With this additional outlet for birds, the production at our game farms has been increased many fold with very little additional overhead cost. In other words, the holding pen program has been the direct means of reducing the cost of birds liberated in the field.

The birds for these holding pens are hatched in electric incubators and brooded in electric brooders at our game farms. The period of brooding lasts about 30 days, and then the birds are ready to be transported to the holding pens where they are held for another period of about seven weeks, when they are old enough to be liberated.

After the birds are out of the holding pens these pens are cleaned and reconditioned and another allotment of birds is placed in them. It is possible to take three allotments of birds through one of these holding pens when cover crop and other conditions are right. Each pen is 24 feet square and 20 birds are allotted to each pen.

As an additional service to these clubs or groups of individuals who desire to help in the propagation and distribution of game birds, the Bureau of Game Conservation has provided the blueprints and material lists for the building of these pens so that all pens, no matter

FIG. 5. A small unit of holding pens at Harbin Springs, Lake County, California. Photograph by author, July, 1935.

where located, are of a uniform size and provided with standard equipment. Feeding formulas are also furnished so that the birds are continued on the same diet that they had at the game farm.

With the operation of these 1000 holding pens in various sections of the State, certain facts have come to our attention. Chief among these is the matter of public opinion. It has been found that where these pens are in operation there is a decided sentiment created for better observance of the game laws. In short, the birds belong to the community and consequently command respect from citizens in general, and any poacher who dares to molest them is promptly brought to court.

Here is an example of just what happens when some of these holding pen birds are molested. The town of Dixon, near Sacramento, has a unit of three pens. These pens are located on the grounds of the local cemetery and the birds are cared for by one of the attendants. In 1934 when the birds of the second allotment were given their

liberty, they took refuge in a nearby tract of ground farmed by some aliens. The farmers at once began to shoot the birds. One of the attendants telephoned the local constable and almost before the smoke had cleared three of them were on their way to tell the Justice of the Peace about it. A fine of $75 was assessed on each shooter, and that seemed to have the desired effect. When the Dixon Club held its annual meeting the writer had the pleasure of seeing this episode enacted on the stage of the American Legion Hall before an audience of 200. Every detail of the episode was carried out with the foreign offenders, prosecuting attorney, judge, etc., making up the usual court scene. The remarks by the judge in passing sentence constituted a masterpiece in depicting what a good citizen should be with reference to observance of game laws and more particularly what the attitude of a foreigner should be in the land of his adoption.

While this holding pen program has demonstrated how public sentiment may be created and crystallized in favor of law enforcement, and how it is possible to raise and distribute more game birds, that is not all of the story. Sportsmen are always interested in what becomes of their money and why they are not getting more fish and game for the small amount that each contributes in the way of license money. Here they have the answer as far as birds are concerned.

Our records show that it costs 10 or 12 cents to hatch and brood a quail or pheasant up to the age at which it is ready to go to the holding pen. From data that we have in our records, turned in voluntarily by many of the clubs that are operating holding pens, it costs about 25 cents additional to carry a quail or pheasant on to the age of liberation. If a reasonable allowance is added for capital investment and distribution charges, the cost per bird is still well under a dollar.

Our experience over a period of four years in working with clubs that operate holding pens shows us that these clubs are not only progressive but constructive. Instead of doing a lot of talking and passing resolutions they are producers

The California system as it stands today consists of artificially produced birds—disease-free and hardy; holding pens, constructed according to our specifications, but paid for and owned by the sportsmen, for the distribution of game birds: and closed areas, made possible by the cooperation of land owners, in which to plant birds where they will have food, water and protection.

CALIFORNIA SEA LION CENSUS FOR 1936[1]

By PAUL BONNOT
Bureau of Commercial Fisheries
Division of Fish and Game

The two species of sea lions inhabiting the ocean waters within the boundaries of the State of California are Steller's sea lion (*Eumetopias stelleri*) and the California sea lion (*Zalophus californianus*). There is also a true seal (*Phoca*) which occurs in such small numbers as to have little importance.

In common with other so-called predatory animals, the sea lions have received their share of condemnation, especially since the inception of commercial fishing in California. About 1900 the commercial fishermen became so vociferous and their complaints were so numerous that a great many sea lions were killed and an investigation of the food habits of the animals was made.[2] Except for scientific notes and an occasional complaint little was heard of the sea lions until 1926. In that year a professional hunter promoted a great deal of dissatisfaction among the commercial fishermen in an endeavor to have a bounty placed on the animals. So numerous became the complaints that an investigation was begun and in 1927 the first complete census ever taken in California waters was successfully made. The conclusions arrived at in the report[3] of this work are that the sea lion population nowhere approaches the numbers claimed, that although some commercial fish are eaten and fishing gear occasionally damaged, the loss inflicted on the commercial fisheries as a whole is of minor importance. It is pointed out that it would be comparatively easy to exterminate the sea lions, but that having done so, it might be found that there are other and perhaps more harmful organisms on which the sea lions act as such an efficient check that they have not, so far, been a detrimental factor in the commercial fishing industry.

In 1928 and again in 1930 the sea lion census was repeated. During this period the total population remained about the same although the geographical distribution changed somewhat. For a good many years the sea lions apparently have been able to maintain themselves at approximately the same numerical strength although in the last few years, added to the natural checks with which they must cope, are humans in the form of collectors for circuses and zoos, trimming hunters, fishermen who shoot sea lions on general principles, and others who kill them for no reason at all.

For several years the sea lions have not received much attention but during the early part of 1936, it was considered of interest to

---

[1] Submitted for publication, November, 1936.

[2] Smith, Hugh M. Report on the inquiry respecting food-fishes and the fishing grounds. U. S. Comm. Fish., Rept. for 1902, pp. 111-142, 1904. (Report on the sea-lion investigations, 1901, pp. 116-119.)

[3] Bonnot, Paul. Report on the seals and sea lions of California, 1928. Calif. Div. Fish and Game, Fish Bull., no. 14, 61 pp., 1928.

ascertain again the status of the animals. In making the previous surveys some sections of the coast were investigated before others and there were gaps of several weeks between the work in one locality and that in another. During the present survey the patrol boat *Albacore* was detailed to examine the entire coast in one cruise. She left Crescent City on June 21, 1936, and completed the survey at the southeast end of San Clemente Island on July 1, touching at all known or suspected rookeries and hauling grounds with the exception of the rookeries at Cape Mendocino and Point Arena. Data for these places were supplied by the respective lightkeepers.

The descriptions and locations of the various rookeries and hauling grounds are set forth at some length in the 1928 report and need not therefore be repeated here.

FIG. 6. Steller's sea lion bull and pups. Photograph by author at Año Nuevo, California, July 2, 1928.

It is at once apparent from the data that little change has occurred in the population and distribution of the Steller's sea lions. The total number of California sea lions has materially increased and a proportionally large number were found in the more northern part of their range, where in previous years only a few stragglers were to be seen. The present breeding range of this species may be said to have been extended, as in former years the most northern rookery used by the Californias was at Point Lobos, south of Monterey Bay, whereas during the present season a small rookery of this species was found associated with the Steller's at Año Nuevo Island, north of Santa Cruz. The California rookery at Frazer Point, Santa Cruz Island, was totally deserted although during the three former surveys it supported a small rookery. Several localities included in the 1927 survey have been

eliminated in subsequent surveys as they were found to be unimportant or nonexistent. Redding Rock, for instance, was reported in 1927 as a rookery of 200 animals, on information derived from fishermen. It was not possible at that time to make a personal inspection. A visit the following year showed that the rock comes straight up from deep water and the only area capable of being used by sea lions would not accommodate more than half a dozen of the animals.

Reference to the table comparing the rookeries for the four seasons in which a census was taken will show how the population shifts from year to year. Some rookeries decrease or disappear and others increase. At Santa Barbara Island there were small rookeries during the first two surveys whereas the next census showed only a few stragglers. During the 1936 season the Santa Barbara Island rookery was the largest California rookery in State waters. A new rookery, not recorded before, is on Bird Rock on the Seventeen-mile Drive at the outer end of the Monterey peninsula. This rock has for years been the hauling ground of a group of seals (*Phoca*) but they have now vacated the rock in favor of the sea lions and have moved to another small rock close by.

The most notable change to be observed among the sea lions is the great increase of adult bulls of both species. Until 1930 adult bulls were comparatively scarce due to the activities of trimming hunters. The trimmings, consisting of the genitalia and gall bladders of adult bulls were sold to the Chinese who manufactured from them an aphrodisiac. Even an earnest desire for sons apparently could not withstand economic pressure and the market for trimmings has become so poor during the last several years that it does not pay to hunt the sea lions. No evidence of systematic hunting was seen and where formerly three or four big herd bulls carried on the necessary breeding in a large rookery composed of several hundred animals, during the present season there were some rookeries with almost as many bulls as cows. The herd bulls have become so courageous that in several places they actually chased humans, an unprecedented occurrence. In previous years the mere appearance of a human near the rookery would cause every animal on it to promptly leave. Despite the great increase in bulls of breeding age little or no fighting was observed. One big bull at the Farallon Islands was badly hurt and profusely bleeding, but whether his hurt originated with another bull or from some other cause was not apparent.

The conclusions of the 1928 report respecting the activities of the sea lions in relation to the commercial fisheries are still valid.

NUMERICAL COMPARISON OF SEA LION ROOKERIES IN CALIFORNIA FOR YEARS IN WHICH CENSUS WAS TAKEN

Rookery	Steller's				California			
	1927	1928	1930	1936	1927	1928	1930	1936
St. George Reef	1,500	611	700	652				
Turtle Rocks	200	200		100				
Cape Mendocino	700	700	900	700				
Pt. Arena	300	206	300	142				
Pt. Reyes				45				9
Farallon Is.	700	540	900	500	6		28	25
Purissima	150	42		4				
Ano Nuevo	1,500	1,500	2,500	1,000				200
Bird Rock				25				250
Pt. Lobos		200	49	60		70	160	3
Copper Pt.								3
Cape San Martin		50						20
Piedras Blancas	212	100	34	6	86	1	23	35
Lion Rock	86			60	21	6		20
Pecho Rock	135	95	300	70	7	75		
Pt. Sal				75	10			150
Pt. Arguello				50		10		20
San Miguel Is.	595	592	620	1,359	149	429	205	520
Sandy Point	49	38	12	52				
Frazer Pt.	2		40		63	88	95	
Gull Is.	18	10	5		150	105	68	200
Anacapa Is.					34	27	11	11
Santa Barbara Is.					125	327	8	600
Castle Rock					29	23	7	35
Seal Harbor	1				235	228	340	400
Totals	6,148	4,884	6,360	4,900	915	1,389	945	2,501

POPULATION OF SEA LION ROOKERIES IN CALIFORNIA IN 1936

Location	Steller's			California		
	Bulls	Cows	Totals	Bulls	Cows	Totals
St. George Reef	131	521	652			
Turtle Rocks	15	85	100			
Cape Mendocino	200	500	700			
Pt. Arena	47	95	142			
Pt. Reyes		45	45	6	3	9
Farallon Is.	100	400	500	9	16	25
Purissima	4		4			
Ano Nuevo Is.	250	750	1,000	30	170	200
Bird Rock	25		25	50	200	250
Pt. Lobos	10	50	60	3		3
Copper Pt.					3	3
Cape San Martin					20	20
Piedras Blancas	1	5	6	1	34	35
Lion Rock	5	55	60	1	19	20
Pecho Rock	12	58	70			
Pt. Sal	30	45	75	50	100	150
Pt. Arguello	6	44	50		20	20
San Miguel Is.	409	950	1,359	126	394	520
Sandy Pt.	2	50	52			
Gull Is.				60	140	200
Anacapa Is.				11		11
Santa Barbara Is.				250	350	600
Castle Rock				1	34	35
Seal Harbor				50	350	400
Totals	1,249	3,651	4,900	648	1,853	2,501

ROOKERIES IN VICINITY OF SAN MIGUEL ISLAND, 1936

Rookery	Steller's			California		
	Bulls	Cows	Totals	Bulls	Cows	Totals
Richardson Rock	50	250	300		-------	-------
Wilson Rock	1	8	9	1	19	20
Flea Is.	113	387	500	125	375	500
Offshore Rock	25	75	100	---	-------	-------
Isthmus Rock	20	30	50	---	-------	-------
Lion Rock	50	50	100	---	-------	-------
Pt. Bennett	150	150	300	---	-------	-------
Totals	409	950	1,359	126	394	520

FISH AND GAME STATISTICS[1]

By GERALDINE CONNER
California State Fisheries Laboratory
Division of Fish and Game

The New Statistical Building

In January, 1937, when the staff took possession of the new Statistical Building, the move emphasized the recognition which has been accorded the fish and game statistics of the State. The statistical program has stepped into the ranks of a major project of the Division of Fish and Game, functioning for the benefit of the entire Division rather than for the Bureau of Commercial Fisheries alone, wherein it was conceived and developed.

A unit of the California State Fisheries Laboratory, the Statistical Building was erected during 1936 on Terminal Island, under the auspices of the Department of Natural Resources of the State of California and the Works Progress Administration of the United States. Third in a group erected on public land, the architecture follows the lines of the research laboratory and the marine patrol office, which combine to form a mecca for conservationists. The construction is steel frame and concrete, the ground floor area is 38x54 feet and the cost was approximately $30,000. The lower floor of the building was designed as a vast fire-proof vault to be used for filing and storing the great mass of records from which the necessary information is gleaned. The small windows are high in the concrete walls, and a series of drop cords provide electrical light between the stacks of files. The construction of this portion of the building is in keeping with the law which requires certain confidential records be retained indefinitely, accessible for use, but adequately safeguarded.[2] A dumb waiter is provided to carry the heavy files to the work rooms on the floor above, and the power plant for the electrical equipment is housed in a protected compartment.

On the second floor there are provided two great work rooms and three smaller offices. The work rooms (18x27 feet each) were planned to suit the particular needs of the equipment used in this unusual work and to relieve the workers from as much eye and nerve strain as possible. The large windows provide adequate light and these rooms are treated acoustically throughout—floor, walls and ceiling. One room houses the battery of electrically operated Hollerith tabulating equipment, ten pieces of machinery through which the masses of records are punched, verified, sorted and speedily tabulated into concentrated form for the use of the administrators. In an ordinary hard-surfaced room, the

[1] Submitted for publication, March, 1937.

[2] "The commission shall preserve all such triplicate copies of receipts (commercial fisheries) in places adequately safeguarded from loss or destruction, and keep them accessible for reference or research." (Fish and Game Code, 1935-37, division IV, part 2, chapter 5, article 5, section 1096.)

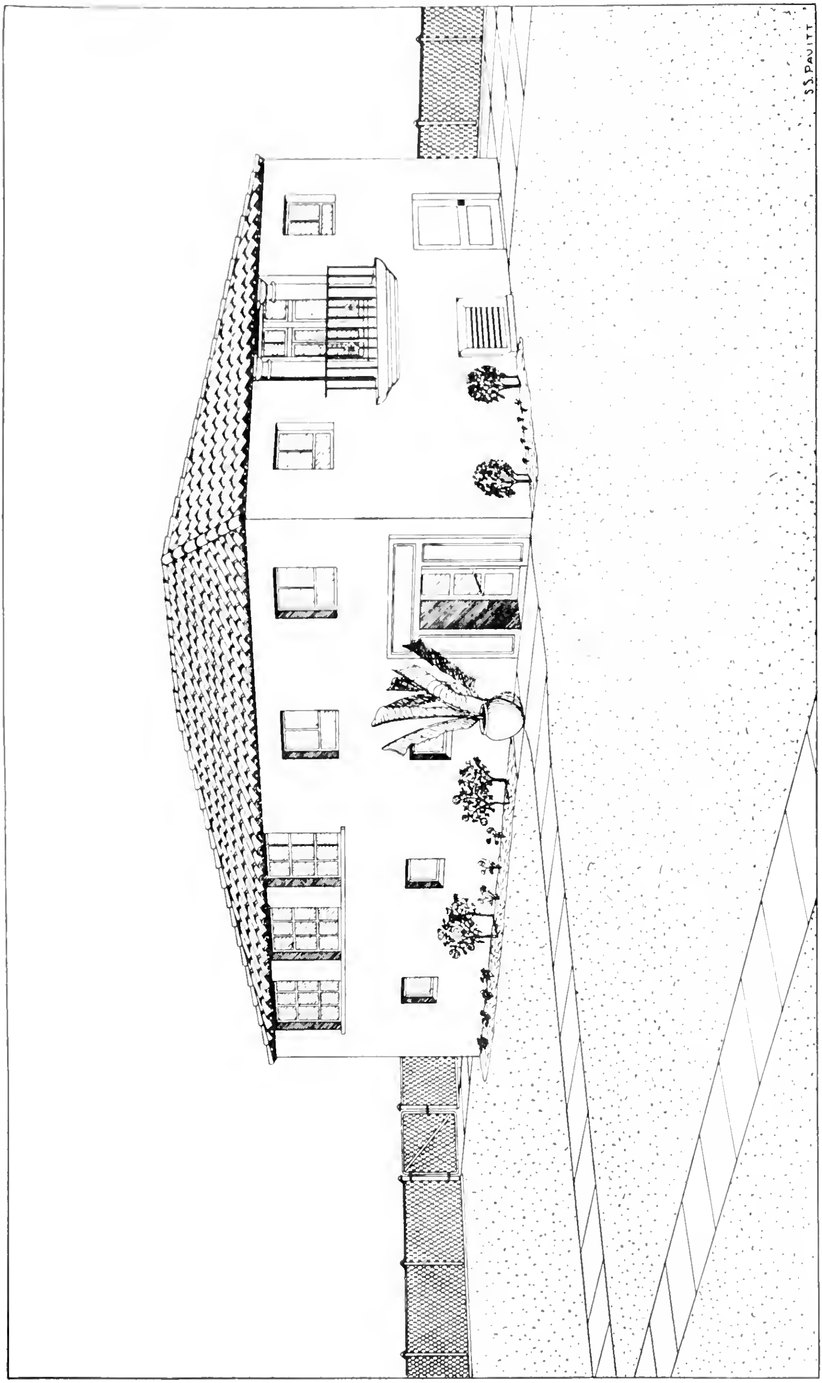

FIG. 7. The new statistical building of the California State Fisheries Laboratory at Terminal Island.

clatter would be brain-splitting and detrimental to a job which requires steady concentration on figures. The second work room provides a quiet haven where the operators and clerks may code, file or prepare the work for the machines.

Two of the offices are used for the supervisory staff and one room is set aside for the use of visiting members of our organization or for the frequent visitors who come from all over the world to use the laboratory's fisheries library and to work with the research or statistical staff.

Types of Statistics

So much for the new building, now to answer the ever recurring questions concerning the need for such an elaborate setting and large staff and the uses to which the statistics are put. To begin with, we tabulate several types of statistics, the varying degrees of completeness depending upon the method of gathering the information, the required results and the length of time the program has been operating. One group of records forms the foundation for biological research, where accuracy of every item is essential and complete data on each area necessary. The collection of this material is backed by laws with heavy penalties for non-compliance and drawn to protect the confidential nature of the individual record involved.[3] In this class falls the commercial fisheries triplicate receipt system. Nearing that perfection is the deer tag record. Next we have the marine sport catch system, complete for ocean fishing from the pleasure boats and barges which are regulated by permit, and since 1935 have been required by law to supply records of the catch and number of people fishing. The sport fishing records are incomplete for the inland waterways where lack of understanding and a spirit of resentment for governmental inquiry have prevented the gathering of complete records. However, in many cases where the pleasure boat owners of inland areas appreciate the value to themselves of the results which will come from the statistics, voluntary records are being supplied for our work. Last come the general estimates, surveys based on the inquiry: "What did you get last year?" which is asked of every hunter and sport fisherman on a questionnaire attached to his application for a license. These statistics are in the formative stage. Of what value they will be to the administrators can not be foretold after the first year's tabulations. The chief objective in all cases is to gain a measure of the abundance and availability of the wildlife and to note the changes over a long period of years. The perfected statistics are giving indisputable evidence of what is happening. The tests being made with the newer pieces of work will prove their value, pointing the way to improvement or modification.

Commercial Fisheries.

About twenty years ago when the Bureau of Commercial Fisheries was in its infancy and endeavoring to plan for the intelligent management of a natural resource belonging to the people of the State, one of

[3] "The receipts, reports or other records filed with the commission pursuant to the provisions of this article, and the information contained therein shall be confidential and the records shall not be public records, and in so far as possible, the information contained in the records shall be compiled or published as summaries so as not to disclose the individual record or business of any person, firm or corporation." (Fish and Game Code, section 1096.5.)

the first steps necessary was to gain information concerning the extent of the fisheries. Proper management and laws depended upon this knowledge. The fish in the sea could not be counted but the amount of fish landed, measured against the amount of effort it took to get them, would, over a period of years, give an adequate working basis. That meant statistics—great masses of figures, boiled down to a few definite facts.

The first records were estimates, but they were a start, better than nothing. Gradually they improved. The enthusiasm of the biologists and statistical staff spread to the administrators, when in actual practice the results of the work proved a rock foundation to combat dangerous legislation and harmful fishing activities. The volume was staggering but the methods of handling improved.

In 1931, mechanical methods were introduced for handling the data and by this time recognition from outside the State and even outside the United States placed California in an enviable position as far as commercial fisheries statistics were concerned. The triplicate receipt system, vessel logs, boat registrations and license applications provide a complete and accurate statistical picture of this State's commercial fisheries. The results, handled by a trained staff of research workers, are conservative and dependable. It is the excellent planning and the careful use of the confidential records of the fishing industry that have enabled this program to reach its high degree of efficiency. Naturally trial and error over twenty years have weeded out its weak points.

In addition to the general commercial fisheries statistics, special records analyze the happenings in the individual fisheries—sardines, tuna, mackerel and flatfishes, each directed by the scientist conducting the biological study. For years, cooperative programs with other governmental organizations have been carried on with the regular routine.

Deer Tag Record.

The Bureau of Game Conservation is concerned with the management of the deer crop in the State. In 1927, legal provision was made for the hunters to report each deer killed with details concerning it to the Division, but the statistical analysis was slow and difficult. The value of the record lay in knowing as the deer season progressed in which county the hunters were making the greatest inroads into the deer, where the season was too early or too late, and where the smaller animals were being killed. The tag provided the information. The commercial fisheries department had the statistical machinery for handling such a record. In 1932, the first tabulations were made at the fisheries laboratory on the yearly kill of some 20,000 to 25,000 deer. From that year on, under the supervision of the statistical staff, deer clerks have turned out the ever improving deer kill record.

The value of this work to the game conservationists is best expressed when we cite the fact that for the 1936 deer season, the U. S. Forest Service called upon the statistical staff to direct a cooperative program. Added measurements which forest rangers had taken, on a sample of 10,000 deer killed in the 18 national forests of the State, were tabulated for analysis.

Hunting License Applications.

Success with the deer record brought forth an ambitious program of general game statistics for administrative purposes. In 1935 hunters were requested to give an estimate of the game they had killed the preceding year, on a statistical questionnaire attached to the hunting license applications. This record was not expected to be letter perfect, it was merely to give the Division a general survey of game conditions in the State. Approximately 200,000 hunters apply for hunting licenses in the State each year and it was gratifying to find that 50 per cent of these sportsmen were interested enough to give a return on this questionnaire the first year. The results were tabulated and some of the estimates obtained revealed surprising facts about the game bird and mammal populations in certain areas of the State. Moreover, what 100,000 hunters reported last year will have some weight when measured against another 100,000 returns for this year and the years following. We had some excellent county by county comparisons which showed such facts as where the most doves were killed, where the plants of pheasants were giving the best returns and where coyotes were the thickest. Augmented by field observations, such information helps the patrol force, the game farms and the war on predators.

Besides the request for statistics the questionnaire carried a space for "Remarks." Here the hunter had a chance to "blow off steam." Some remarks were vitriolic, some were stupid, but there were constructive suggestions made by intelligent sportsmen interested in the welfare of the game. A few theme songs from given areas, where the laws might bear improvement, will be given full consideration.

Marine Sport Catch.

The marine sport catch has been carefully planned and several years of educational work preceded the actual statistical program. The results of this care produced usable records from a group of pleasure boat and barge owners the first year. The preliminary preparations will simplify the enactment of proper laws to insure the collection of similar records from inland waters in the future.

The thousands of marine sport fishermen are drawing more heavily each year upon the same supply as the commercial fishermen, protesting the shortage of desirable species with little realization of the toll they are taking. So closely allied are these two types of fishing that it will be impossible much longer to administer to the commercial fisheries without statistical information concerning the marine sport catch. The volume is greater than is realized and in many cases exceeds the take of the commercial boats.

Angling License Applications.

Following the lines of the questionnaire attached to the hunting license applications, the record on the angling license applications is merely an estimate. The results obtained from the first year's returns given by 50 per cent of the anglers have shown us that the records will furnish us with much of the general information we desire, although many of the individual reports obviously have been affected by reticence, exaggeration or failure to remember. When analysed

with due regard to the source, the data given on the applications will prove to be of real value.

Interpretation of Material

From 1931 until 1937 the statistical work has snowballed until the volume is five or six times greater than it was when the mechanical tabulating devices were installed. The acknowledgment of the success of the commercial fisheries statistical program planned with such circumspection has led to an enthusiasm for statistics which is both gratifying and precarious. Statistics of our fish and game to be of full value need the interpretation of experts with an understanding of the individual species, local conditions and the degree of error in the material collected.

Because we are producing tabulations in varying degrees of perfection there is the danger of misjudging an estimate as a finished piece of evidence, and confusing scientifically correct data with superficial pieces of work. It is our present endeavor to avoid further expansion until all of the work in hand may be made impeccable. With the advantage of working quarters explicitly suited to the work we are in a position for the first time to get the maximum value from the available material.

MAGNETIC RECOVERY OF FISH TAGS[1]

By DONALD H. FRY, JR.
California State Fisheries Laboratory
Division of Fish and Game

The usual method of tracing migrations of fish or other animals is to tag or mark as many healthy individuals as possible in a way which will be readily noticed. Fish are marked by clipping fins, by tattooing and by tagging.

Fin clipping is generally used when the fish to be marked are very young—for instance, young salmon migrating down stream are sometimes marked in this way. The method is fast and if properly done it is permanent. The disadvantages are many. It is not very noticeable and if noticed may be attributed to a seal bite or some similar accident. It may seem too troublesome to the finder to hunt up the proper authority before the fish spoils or properly to preserve his find in case he chooses to send it in. Fin clipping can not be scattered over a large number of places and dates as a fish does not have many fins and there are not enough distinctive ways of clipping them to keep separate very many batches of fish.

Tattooing is more or less permanent and each fish can be given a serial number. However, writing out a large number with a tattooing needle is very slow. The way in which tattooing has proved most valuable is in conspicuously marking a tagged fish on which the tag alone would not be readily noticed. For example, halibut are tagged on the gill cover on the upper side. A tag on the lower gill cover would probably be scraped against the ocean bottom until it worked loose. However, the halibut fishermen nearly always slide the fish aboard with the bottom side up. A tattoo mark on the bottom side thus keeps the tag from passing unnoticed.

Tagging is the most commonly used method of fish marking. The tags are easily applied, they are serially numbered so that a record can be kept of each fish, and it is a simple matter for the finder to drop a tag in an envelope and mail it to the proper authorities with a statement of when and where the fish was taken. The chief disadvantage is that the more conspicuous tags are rather readily lost by the fish, more so by some species than by others.

There are many types of tags. Some are large, some small, some clip on fins or gill covers, some consist of two buttons held together by a wire which passes through the back muscles of the fish. The tag having the least chance of being lost is a flat piece of metal or celluloid which is placed inside the body cavity of the fish through a small slit. Obviously, this type is also the most inconspicuous.

No matter what sort of marking is used, the success of the whole plan hinges on one thing. Neither tags, clipped fins, tattoo marks,

[1] Submitted for publication, March, 1937.

nor any combination of these can succeed if no one notices the markings.

There are some species of fish with which the chances of any one noticing a marked individual are slim indeed. These are fish that are caught by the boatload, unloaded with huge dip nets a thousand or two at a time, and either cleaned and beheaded by machinery or else carried on a mechanical conveyor direct to the fish meal plant. Obviously fishermen and cannery workers are not at all likely to notice one tagged fish in the middle of a pile containing many tons of untagged ones. Two species which are handled in this way are the subjects of tagging experiments: the Alaska herring and the California sardine. Nearly all the herring and sardines, or the offal therefrom, pass through reduction plants and it is in these plants that recovery of tags must be made.

George Rounsefell, of the U. S. Bureau of Fisheries, who was doing research on the Alaska herring, conceived and carried out the idea of using tags which could be recovered by magnetic methods. Various types, sizes and materials were tried. The one finally selected was an internal tag of nickel plated steel measuring about $\frac{3}{4}$ x $\frac{1}{6}$ x $\frac{1}{25}$ inches (19 x 4 x 1 mm.). This was large enough to be readily noticed and flat so the magnetic collector could get a good grip on it. Corrosion is not a serious problem when internal tags are used—apparently the body tissues of the fish use up all the available oxygen. At first, the tags were recovered after the fish had been made into meal. This was done with comparatively simple equipment but had some serious disadvantages. It was impossible to check on the growth or condition of the fish and, far worse, the tags were likely to "hang up" somewhere in the reduction plant for days or even weeks. During this period, the fishing fleet might have fished in several different areas. As a result this method could not give accurate information about *short* migrations. For long migrations, it was perfectly satisfactory, as the herring boats never operate any distance from the plants. To overcome the difficulties just mentioned there has been installed some far more elaborate equipment which recovers the tagged fish as they pass down a flume from the boat to the plant.

In the case of the California sardine, the details about short migrations are of minor importance and there are so many plants that it is out of the question to equip all of them with the more elaborate collectors and to supply enough men to keep the close watch which such equipment demands.

As a result, when the California Division of Fish and Game started its sardine tagging program it was decided to use the simpler devices first mentioned. These are known as magnetic separators. There are many types used to separate magnetic from non-magnetic materials in factories, mines and mills all over the country. The tags decided upon were internal ones of nickel plated steel about the same size as those designed by Rounsefell.

After a careful examination of various types of magnetic separators, it was decided that the best for use in the California plants was one of the smallest and simplest. It was designed for use in flour mills to keep stray pieces of iron out of the grinder. It consists of a power-

ful electro-magnet which magnetizes an iron plate. This plate forms part of the bottom of an enclosed chute. Grain (or fish meal) passes down the chute and into the grinder. Nails, nuts, bolts, horse shoes, and monkey wrenches do not—thus saving much wear and tear on the grinder, and in the case of flour mills, many explosions. (Under some conditions, flour dust is highly explosive and plenty of sparks as well as some rather terrifying sounds are provided by a grinder hard at work on a half-inch bolt.) These small separators, though designed for grain, will work satisfactorily on almost any substance which is in fairly small pieces, does not form into large lumps, which will readily slide down the chute, and which does not contain so much "tramp" iron that the magnet is overloaded.

A brief examination of a fish meal plant will reveal that there is only one stage in the manufacturing process during which the tags can be extracted with this type of magnet. Whole fish, as well as fish heads and offal from the cannery, enter the plant on a conveyor, go into a cooker, from there to a press which squeezes out the oil, then into the hasher (a monstrous meat grinder which is so coarse that tags pass through it uninjured), then into the dryer. From the dryer, the meal emerges dry and well broken up and passes by means of a conveyor into the grinder which pulverizes it. Not until it has emerged from the dryer is the meal in such condition that the tags can be readily extracted from it. Obviously then, the one satisfactory place for the magnet is between the dryer and the grinder.

Having determined what equipment was necessary and how it should be installed, the Division of Fish and Game obtained the cooperation of the cannery owners in the matter of installation. The benefits to the canner, which would arise from keeping tramp iron out of the grinder, were apparent. Many canners realized that the rapid wearing out of expensive grinder screens was largely due to tramp iron, others did not believe that enough went through their plants to cause any great damage, but nearly all were willing to install and operate at their expense any magnetic separator which the State would supply. A few had already installed their own separators, and a somewhat larger number had plants so designed that an installation would have been too difficult and expensive to be practical.

This much having been learned, a single separator was ordered, installed under the supervision of an expert, and given time to prove its merit. A few minor changes in the installation were necessary due to the differences between fish meal and grain. Then, the "bugs" having been ironed out and the apparatus proven satisfactory, 25 more were purchased by the Division of Fish and Game and installed at San Francisco, Monterey, San Pedro and San Diego.

The structure of the magnet and the usual method of installing it are shown in figure 8. The coil is roughly 5 inches long by 6 inches in diameter. There is a heavy iron core with two end plates. Fastened across the end plates is a sheet of iron over which the meal slides. This sheet is about 8x16 inches. Set into it are a lip and a trap door. The lip is simply a bent-over portion of one end plate which passes through a hole in the floor plate. The upper edge of the lip slopes gradually away from the floor plate; the lower edge is quite sharp and so forms a space where iron can lodge and not block the flow of meal. Inciden-

tally, the pull of the magnet is strongest at this point. Below the magnet proper is a trap door in the floor plate. The theory is that when the current is turned on the door is held shut by the pull of the magnet, and when the current is cut off the weight of the door swings it open and the magnet's load of tramp iron and fish tags goes through the door instead of into the grinder. The trap door probably works when the separator is used on grain, but fish meal forms a fine dust which gets—among other places—into the hinges of the trap door and gums them up enough so that the trap can not be trusted to work automatically.

As the magnets require direct current, and as without exception the canneries and reduction plants in California are supplied only with alternating current, it has been necessary in every case to supply a rectifier with the magnet. These are all of the copper oxide two-stack

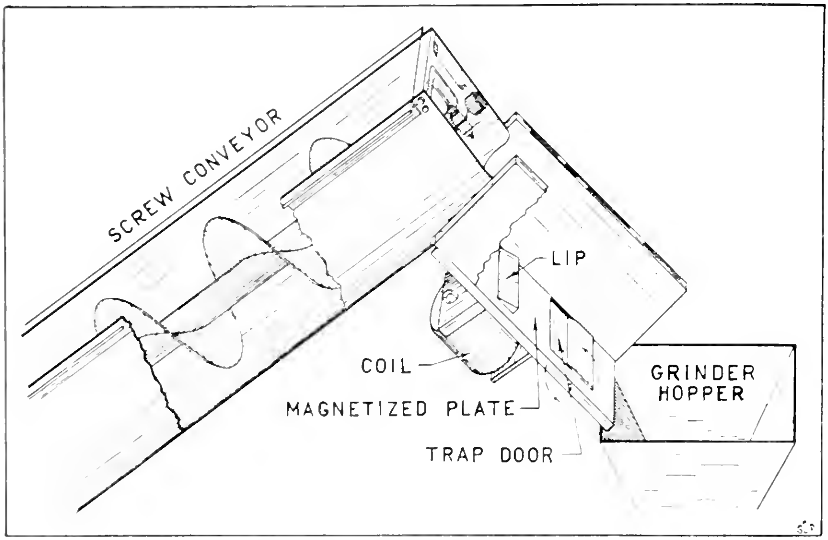

FIG. 8. Diagram of magnetic separator in place.

type and were furnished by the same firm which made the magnets. Although the magnets have given satisfaction, the rectifiers have given considerable trouble.

The installation of the magnets was done by the mechanics at the canneries and reduction plants under the general direction of a member of the California Division of Fish and Game. Installing a magnet is in many cases a very simple matter. There are a few rules to be followed and after that it is a case of mechanical ingenuity in finishing the job. The floor plate should be set at an angle somewhere between 45° and 70°. If the slope is less than 45°, the first piece of iron that comes along stops as soon as it hits the upper edge of the floor plate; the meal is moving slowly and does not have enough force to slide the iron over the edge of the lip, but tends to pile up back of it instead; if there is much iron the chute is soon blocked. On the other hand if the angle is greater than 70°, meal and iron are practically falling and some of the iron may not be caught at all. An angle of about 50° to

55° seems to be best—the meal will not pile up, but goes slowly enough so that the magnet is able to catch and hold all iron.

The sides of the chute should be of non-magnetic material. If they are of iron they will become strongly magnetized near the magnet, less so at a distance from it, so that some iron may stick to the side, be slid by the meal slowly along the side, past the magnet and down to a place where the magnetism is no longer great enough to hold it.

In some plants a good installation can be easily made; in others, space is so limited that *any* installation becomes very difficult indeed. The most common trouble is that there is not 16 inches of space between the bottom of the conveyor and the top of the grinder. Occasionally it is a simple matter to raise the conveyor, but usually it is necessary to cut down the magnet instead. This operation is a simple one: the floor plate is cut off between the trap door and the coil, and the trap is discarded. This is no great loss since as mentioned above, it does not work any too well in a fish meal plant. Additional space can sometimes be gained by cutting a notch in the grinder top—but most grinders are so designed that this is not advisable. Occasionally, when everything else is impractical, it is possible to install the magnet between the dryer and the conveyor or in the bottom of the dryer just above the outlet. A magnet in either of these places is very inaccessible and such installations should be used only as a matter of last resort.

No matter what type of installation is used, there should be a switch placed within reach of the magnet to make removal of tramp iron as simple as possible.

The quality of installation has varied widely. In one case, wood was so neatly mounted all around the magnet that a cabinet maker might have been proud of the job, and then this wood was covered with heavy iron—a precision fit with all joints neatly welded. In the other extreme, one mechanic did such a poor job that the magnet was ruined and had to be recalled. Most of the installations were neat workmanlike jobs allowing the magnet to operate at full efficiency. Some mechanics, on the other hand, were so used to thinking in terms of iron that they disregarded instructions to use some non-magnetic material for the lining of the sides of the chute and thus reduced the efficiency of the magnet to some extent.

The method of "clearing" is first to divert the flow of meal—usually by opening a dump gate in the conveyor and letting the meal drop onto the floor, then open the trap door, shut off the current, brush off any iron that does not drop off, turn on the current, close the trap door if it sticks open, start the flow of meal again, and shovel up what is on the floor. Instead of using the trap door, some operators prefer to hold a cigar box under the magnet when the current is cut off. When a separator is minus its trap door this is the only method which can be used.

Everything that comes off the magnet is saved by the plant operator until collected by a member of the Division of Fish and Game. It is then screened to remove fish meal and small pieces of iron, and is then laboriously picked over for tags. The amount of metal collected at the average cannery usually ranges from a pint to a quart per week, but may run higher if any great amount of repair work has been done. Some of the more common things collected are: nails, fish hooks,

nuts, bolts, ball bearings, scraps of "tin," bottle caps and unidentifiable fragments usually very small but occasionally as large as two or three pounds. Some rarer items are: screw drivers, wrenches, knives, and once a small grease gun in perfect working order. Workmen invariably drop such things as those mentioned, all of which seem to have a sort of homing instinct which guides them to the reduction plant. Plants which do reducing only (i. e., no canning) have much less equipment from which parts are apt to drop and fewer employees to drop things, hence much less tramp iron.

Plant owners are glad to have this tramp iron problem solved, and most of them are more than satisfied with the magnets. In several plants the owner has said that he would be glad to buy the magnet or would replace it with a new one if the State should want to discontinue this work.

The number of tags collected by all 29 magnets (26 State-owned and 3 private) usually ranges from none to 5 or 6 per week. On one gala occasion a single cannery produced 24 tags in one week—but that record has never been approached.[2]

On the whole, our present method of tag collecting seems to be entirely satisfactory. It would be to our advantage to be able to collect the tagged fish instead of just the tag, but at present the benefits do not seem to be worth even a small part of either the extra labor or the extra equipment, which would be needed to make this possible.

REFERENCES

Dahlgren, Edwin H.

1936. Further developments in the tagging of the Pacific herring, *Clupea pallasii*. Cons. Perm. Int. Explor. Mer, Journ., vol. 11, no. 2, pp. 229-247, 7 figs.

Rounsefell, George A., and Dahlgren, Edwin H.

1933. Tagging experiments on the Pacific herring, *Clupea pallasii*. Cons. Perm. Int. Explor. Mer, Journ., vol. 8, no. 3, pp. 371-384, 6 figs.

1935. Races of herring, *Clupea pallasii*, in southeastern Alaska. U. S. Bur. Fish., Bull., vol. 48, no. 17, pp. 119-141, 10 figs.

[2] By March, 1937, the average number of tags recovered had risen to over 30 per week. The sardine season closed March 31.

TAGGING PACIFIC MACKEREL[1]

By DONALD H. FRY, JR.
California State Fisheries Laboratory
Division of Fish and Game

In 1928 the canning of Pacific mackerel suddenly became a large industry, operating on the well-established American plan which assumes all natural resources are inexhaustible until they are practically exhausted. Such huge tonnages of mackerel have been taken that there is every reason to suppose the supply will not last unless some well thought out plan of regulation is put into effect. Tagging is a necessary part of the research on which such a plan must be based. Consequently, the California Division of Fish and Game, through its fisheries laboratory, has instituted a mackerel tagging program.

Canning operations are what endanger the fish. The men who fish for sport and for the fresh fish markets take so little by comparison that in a depletion study, their efforts can be practically disregarded. There has been some canning at Monterey in central California and some at Ensenada, Lower California, but the really heavy fishing has been in southern California, from Ventura south to the international line—a distance of about 160 miles. During the last few years the quantities taken in this small area have been far larger than the mackerel landings of the entire Atlantic coast—and the Atlantic fishery is a heavy one. Obviously it is not safe to assume blindly that this small area is actually producing more mackerel than the huge fishing grounds of the Atlantic—and if southern California is not producing all its fish, where are they coming from? The range of the species is from Vancouver Island to the tip of Lower California. Are the canneries taking fish from this entire length of coast? The fishing grounds of all this coast, by the way, are only about 37 per cent as large as the mackerel fishing grounds of the Atlantic. There is known to be much heavier spawning off Lower California than off southern California. Is Mexico producing our fish? Does a large part of our local population move south into Mexican waters to spawn? Is our population merely the overflow from a much larger Mexican one? Do the two regions have distinct populations with little or no migration back and forth? If we destroy our own population, will more fish soon move in from somewhere else, will there be other populations to the north and south of us which will *not* move in, or will we have depleted the mackerel population of the entire Pacific coast? These vital questions and many others can best be answered by tagging large numbers of fish over a wide area.

Tagging consists of fastening to the fish some sort of tag, band or label so that it can be definitely identified at a later date, turning it loose, and waiting for some one to report where it was next seen. If

[1] Submitted for publication, March, 1937.

the movements of enough individuals can be checked in this manner it is possible to obtain very definite knowledge of the movements of the entire race.

In this region there are two methods of finding tagged mackerel. The obvious and time honored way is for some fisherman to notice the tag on one of his catches and either send or take it to the laboratory carrying on the investigation. This method is fairly satisfactory in the case of mackerel, because numbers of these fish are caught by sportsmen and market fishermen who would be apt to see the tags. A more recent method is to use magnetic tags and recover them with magnetic collectors. This method is more likely to get the tags from those mackerel caught in large scale cannery operations, where fishermen and workers handle so many fish they do not look at any closely.

When the California Division of Fish and Game started its sardine tagging program, magnets were installed in fish canneries and reduction plants all over the State.[2] The sardine and mackerel tagging programs were started about the same time. The magnets were not absolutely essential to the success of the mackerel work, but they were already being installed and there was every reason to take advantage of them, so the mackerel tags were made of pure nickel which is magnetic and does not corrode in sea water.

As an inducement to fishermen to let us have any tagged fish they may take we are offering 75 cents for the return of each mackerel with tag in place, or 50 cents for the tag alone. Full information as to where and when the fish was taken must accompany the tag. Fish or tag may be taken to the California State Fisheries Laboratory, Terminal Island, or the San Diego or Monterey offices of the Division of Fish and Game; or mailed to the California State Fisheries Laboratory.

By offering the extra 25 cents for the fish, we have been able to keep track of the way in which the tags are staying in place, and we may eventually accumulate some valuable information on growth rate. Illustrated notices are posted in most places where fishermen are apt to land mackerel, such as canneries, markets and pleasure fishing piers.

Types of Tag Used

The type of tag originally chosen is shown in figure 9. It is of the strap type and is designed to fasten onto the gill cover. It is applied with a special pair of pliers which forces the point through the gill cover and locks the tag shut. When closed the tag measures $\frac{1}{8}$ of an inch wide by $\frac{3}{8}$ of an inch long.

Up to the present time a bright red celluloid band has been placed around one end of each tag to make it more readily noticeable, particularly in the dim light of a cannery. It has become evident that the workers are almost as mechanical in their motions as the cleaning machines themselves, and do not notice the tags even when the bands are in place. The bands may be abandoned in the future for this reason and also because they doubtless increase the chances of a fish being singled out by a predator as well as being an irritant to the fish.

When we first obtained the strap tags, we had trouble with a slight wire edge which was present on all of them. After sending the tags

[2] See "Magnetic recovery of fish tags," pp. 119-124.

back and getting a slight improvement we started to use them. It soon became painfully evident that they were very irritating to the fish, and in many cases were enlarging the hole in the gill cover and falling off. Since making this unpleasant discovery, we have smoothed each tag before using. A drum, 9 inches in diameter by 2 feet long, was given a ridged inside surface by nailing on $\frac{3}{4}$-inch half round strips of wood. There were 16 such strips, each one going the full inside length of the drum. The whole was lined with fine emery cloth and revolved on a small lathe at 55 r.p.m. A four to eight hours' ride in this device leaves a batch of tags in excellent condition. The ridges in the drum are necessary—otherwise, the tags get worn too much on the ends and not

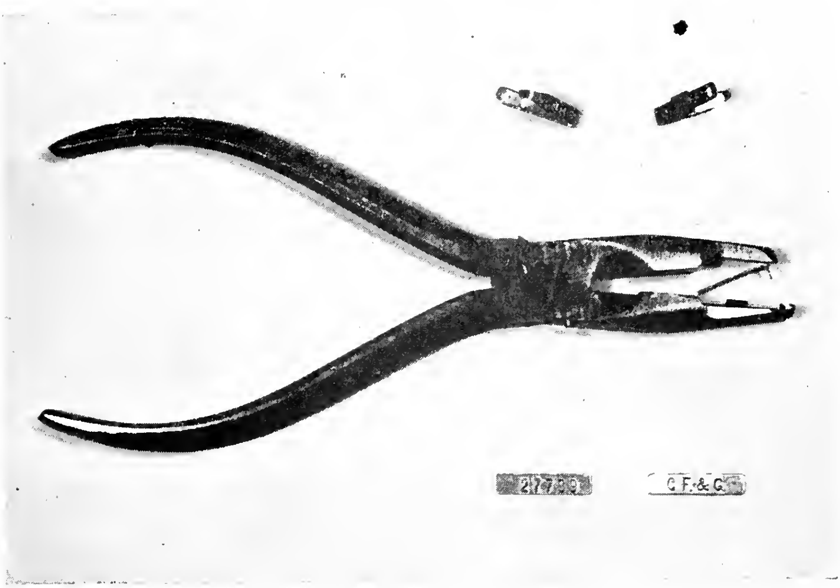

FIG. 9. Mackerel tags and tagging pliers. The strap tags shown at the top are clinched into the gill cover of the fish with the pliers. The pliers force the point of the tag through the gill cover, through the hole in the other end of the tag, and bend it over. The pliers are quite simple but must be very accurately made if they are to work properly. A tag is shown in the pliers, ready to apply. The internal tags, shown below, are inserted into the body cavity of the fish through a small slit made in its side. The internal tags are used for both sardines and mackerel.

enough along the edges. The operating capacity of the drum just described is probably about 5,000 tags. It works very nicely with 1,000 and 3,000 (the largest number we have put into it).

After smoothing, the tags irritate the fish much less and seem to stay on better, just how much better we can not say until more time has elapsed.

Another thing was done when it became evident that the strap tags were none too permanent; that was to experiment with the most enduring type of tag yet devised.

Internal tags or belly tags are flat pieces of celluloid or metal which are slipped into the body cavity of the fish through a tiny slit made in its side. If properly inserted, there is very little chance of

their being lost. This makes them suitable for tracing long migrations, but for tracing short movements they are not at all satisfactory. Being inside the fish, they are not readily noticed, hence we must use metal tags and depend on magnets for most of our recoveries. The magnets in use in California do not recover the tag until the fish heads and offal have been made into meal. The delay involved makes it impossible to learn what boat took the fish or where it was taken. All we can be certain of is that the place of capture was within 75 miles of port, since the mackerel and sardine boats never operate more than that distance from the cannery. At times there are many mackerel mixed with the cannery sardine catches, so we can expect recoveries even when the boats are not fishing for mackerel.

Tagging Methods

The method of tagging mackerel has undergone many minor changes since it was first started. The present system is about as follows: The boat is anchored and live bait or ground-up fish is thrown into the water to chum up a school. While this is being done, an impounding net, about 12 feet across and 4 feet deep, is tied to the side or stern of the boat. If the fish are ravenous, or can be gotten into a frenzy of excitement by proper chumming, everyone fishes with a bamboo pole, 2 to 5 feet of line, 18 inches of wire leader, and a feather striker with a barbless hook. A mackerel hits the striker, is flipped into the impounding net and allowed to spit the hook out. If the job is done properly the fish will usually be rid of the hook while still in mid air, or within a second or two after landing. The commercial fishermen's way of cracking the whip will loosen the hook instantly, but this method can not be used on fish which must be released uninjured. When fishing slows down, part or all of the crew use bait on striker hooks which have lost their feathers. If the fish get still more particular, it is necessary to use a gut leader and an ordinary 3/0 or 4/0 hook which has had the barb flattened. Each fish has to be unhooked from this rig by hand—and it is hard on the hands. A hand line is the last resort; it is used only when the mackerel refuse to come to the surface. At Monterey and other points where the mackerel apparently do not school so readily, hand lines are used exclusively.

When fishing gets too slow or the impounding net becomes crowded, part of the crew stops fishing and starts the actual tagging operations. Preferably at least one man continues to chum and fish, and if the mackerel suddenly start to bite again everyone grabs a pole until the spurt is over.

Tagging operations can be efficiently carried out by crews of 2, 3 or 4 men. When four men are used, the work is arranged as follows: One man dips a fish out of the net and holds it in front of the measurer who lifts it out of the dip net onto the measuring board, calls out the length and lifts the edge of one gill cover. The tagger, using a special pair of pliers, slips the tag into position, clinches it shut, and then removes and reloads his pliers while the measurer is getting that fish overboard and grasping the next one. A fourth man keeps the records, noting tag number and length of fish.

When internal tags are used the process is very much the same for everyone except the tagger. This man uses a scalpel to make a tiny slit in the side of the fish, inserts the tag part way with his fingers and pushes it clear in with a pair of forceps.

Unlike some other fish, mackerel do not lie quietly and allow the routine to go along smoothly. They could give lessons to the proverbial greased pig and consequently the recovering of fumbles is all too common a part of any tagging trip. Two other pet stunts are knocking the tag out of the pliers and curving its body into a rigid arc. This last makes an accurate measurement impossible but does lift one gill cover and makes things easy for the tagger.

Location of Tagging Operations

At the end of 1936, a total of 4051 mackerel had been tagged. The range of operations was from Monterey, California, to Magdalena Bay, Lower California—a distance of about 1000 miles. Of these fish, 737 were tagged at Monterey, 2113 in southern California between Pt. Dume and San Diego, 960 in Sebastian Viscaino Bay (half way down the coast of Lower California) and 241 in more southern waters.

Recoveries

As mentioned above, 4051 mackerel had been tagged by the end of 1936. Of these, 209 had been recovered. This is a good return and shows promise for the future, but it is still much too soon to attempt to draw any conclusions regarding the movements of the fish.

Location of Future Tagging Operations

From our present knowledge it appears that we should increase the intensity of tagging in the areas already worked rather than try out any new ones. The important regions are:

1. *Sebastian Viscaino Bay, Lower California.* There is no mackerel fishing done in this area and no chance of recovering any fish tagged there unless they move at least as far north as Ensenada or San Diego. A migration of this distance is bound to take time, hence permanence of the tag is of vital importance. For this reason, large numbers of internal tags should be used, at least until we are sure that our thoroughly smoothed strap tags are staying in place. Small mackerel abound in several places along the mainland shore of Viscaino Bay. These should be tagged almost exclusively with internal tags, as young fish are even more prone to lose strap tags than adults and will have to grow for a year at the very least before they become large enough to enter into the cannery catch in any numbers.

2. *San Quentin, Lower California.* This area is about half way between Viscaino Bay and San Diego. There are mackerel in the region and it would be advisable to tag some if a good opportunity presents itself, or if we have difficulty in getting enough fish farther south.

3. *Monterey, California.* This area is the farthest north that mackerel are taken in quantity. There is a good sized market fishery and some canning is done. The canneries are equipped with magnets.

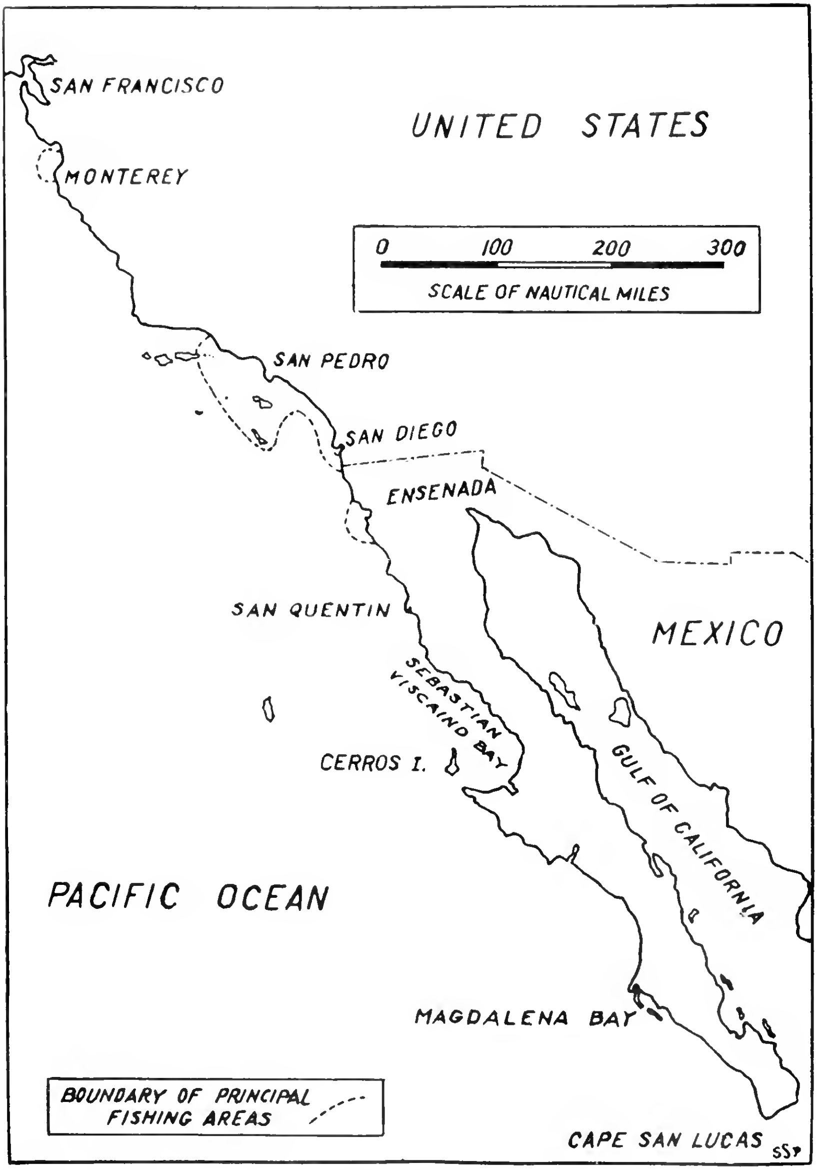

FIG. 10. Map showing the territory included in the mackerel tagging operations. Tagging has been done from Monterey in the north to Magdalena Bay in the south. Recoveries can be expected only in the areas of heavy fishing.

The important thing to learn at Monterey is whether or not the fish in that region move to and from southern California. Details about minor movements in the vicinity of Monterey are not important.

4. *Southern California.* This region is the one where most of the fish are taken and hence where most recoveries are to be expected. Tagging should be done to enable us to learn to what extent the fish move north to Monterey. The trip is a long one and internal tags would seem to be in order for a large part of the fish. Many strap tags should also be applied as it is only by their use that we will be able to learn what minor movements take place within this comparatively large area. Tagging, particularly strap tagging, should be scattered over as many places as possible. The fishing should be done in the open, a mile or more from shore when possible. The greater part of the population stays fairly well offshore and it is possible that by fishing in sheltered places we would get mackerel with well established habits, quite different from those of the great majority.

In conclusion it can be said that the mackerel tagging program has shown more than enough promise to warrant its continuance. It will be pushed with vigor and we can look forward to an increased knowledge of the habits of the mackerel and a better insight to their abundance.

THE RELATION BETWEEN SURFACE WATER TEMPERATURE AND THE DISTRIBUTION OF SPAWN OF THE CALIFORNIA SARDINE

Sardinops caerulea [1]

By RICHARD B. TIBBY
California State Fisheries Laboratory
Division of Fish and Game

It has been known for many years that changes in temperature have a profound effect on a large number of physiological processes such as the rate of metabolism, growth, and reproduction. Under constant temperature conditions, these processes proceed at a characteristic, uniform rate and a rise in temperature results in an acceleration of the rate.

The ascending curves of growth, reproduction, and metabolic processes in general of invertebrates and cold-blooded vertebrates, such as fishes, are subject to seasonal interruptions and proceed at a faster rate in summer than in winter. This has been interpreted as being due to several causes, the most important of which is the annual rise and fall in temperature. It is interesting to note that a rise of one degree Centigrade increases the rate of metabolism by roughly ten per cent, and a rise of ten degrees doubles the rate of metabolic processes.

Orton (1920) has shown that the breeding seasons of many animals lie within comparatively small limits of temperature, and has found that the Atlantic mackerel (*Scomber scomber*) begins to spawn at 12–13° C. He also states that "* * * a minimum breeding temperature would therefore appear to be a physiological constant for the species." There is then a temperature threshold below which metabolic activities are at so low a level that the gonads do not develop and spawning will not take place. This is presumably the case with the California sardine, where the lower limit of spawning lies in the neighborhood of 13° C. Two other fish for which a definite temperature-breeding correlation has been shown are the herring (Hjort, 1910) and the yellow perch (Lea, 1913). There are others too numerous to mention here.

Attempts have been made to find a correlation between spawning and salinities. Nilsson (1914) found in the case of the eggs of the Atlantic mackerel that "* * * the most important factor concerning the distribution is undoubtedly salinity * * * the low degree of salinity in the waters of the inner fjords at the same level accounts for the absence of mackerel eggs in this locality." The concensus of opinion, however, regarding salinities and breeding is summed up by Orton (1920) in his statement that "* * * investigations on the

[1] Submitted for publication, March, 1937.

breeding periods of animals have strengthened the view of the importance of an appropriate temperature and weakened that of the effect of *normal* changes in salinity in controlling breeding in marine animals in general.'' The observations by Clark (1934) tend to support this view; she found that the percentage of maturing eggs of the California sardine showed no correlation with salinities. Schmidt (1909) on the other hand believes that there is a sensitivity to salinity variations in the spawning habits of some fishes. This is represented in the extreme cases of the fresh-water eel (*Anguilla vulgaris*) which spawns in the ocean at a great distance from its ordinary habitat, and the various species of salmon which live in the ocean but ascend the streams to spawn. Although many obscure factors are here involved, it is probable that salinity plays an important part in this phenomenon. It seems more reasonable to assume that ordinary fishes, such as the sardine, are not greatly affected by the small variations in salinity which are ordinarily encountered throughout their spawning ranges. More work, however, needs to be done, and salinity analyses should be a part of the routine work of plankton hauls for eggs and larvae.

Although salmon and the fresh-water eel are not typical cases but rather represent extremes, they are nevertheless good illustrations of the fact that the distribution of a fish may be much wider than its spawning range, and that spawning does not necessarily take place throughout the entire range of the species. Recognition of this principle led Schmidt (1909) to make the statement that ''* * * * the spawning region of a species is often much more restricted than its distribution in general,'' and that this restriction is determined by definite hydrographical conditions. This is found to be true of the California sardine in that spawning is largely restricted to the more southern part of its range.

Analysis of the Sardine Data

It was found by Scofield (1934) and later confirmed by the writer that there exists a definite relationship between surface water temperatures and the distribution and abundance of sardine eggs, but an analysis of the data on which this relationship was based has not hitherto been published.

The California sardine (*Sardinops caerulea*) is found over a great area, from southern Alaska to Cape San Lucas, Lower California, but spawning is largely confined to the southern part of its range. The eggs are pelagic and spawning takes place near the surface. Scofield (1934) established that there is a region of maximum spawning which lies between Point Conception and San Diego and offshore for some one hundred miles. To the north as far as San Francisco intermittent spawnings were found inshore, but only in localities where the temperature was greater than 13° C. During the four years covered by his investigation (1929 to 1932), 1930 and especially 1931 were years of unusually high surface temperatures both north and south of Point Conception and only during those same two years were sardine eggs found inshore in northern waters. Even then the eggs were present in only relatively small numbers and in restricted and unpredictable localities. This led to the conclusion that in normal years temperature conditions were unfavorable for spawning inshore north of Point

Conception. Conditions in the warm California current are discussed below.

In 1936 two trips were made by the writer into Mexican waters along the coast of Lower California in an attempt to determine the extent of spawning and the season in which spawning occurred in this region. The results of these trips and several made previously show that the spawning season in more southern waters probably starts earlier than in those off the southern California coast. Spawning has been found in Lower California from the early part of February to the middle of July. The spawning in February, 1936, was fairly heavy, and it is felt that the season may begin in January or possibly in December. There are no indications at the present time that spawning begins before February in the waters off southern California. Although no attempt was made at quantitative estimates, it was apparent that there was a sizeable spawning in the Sebastian Viscaino Bay region and some localized spawnings were found as far south as Cape San Lucas. The importance of this southern spawning can not as yet be told.

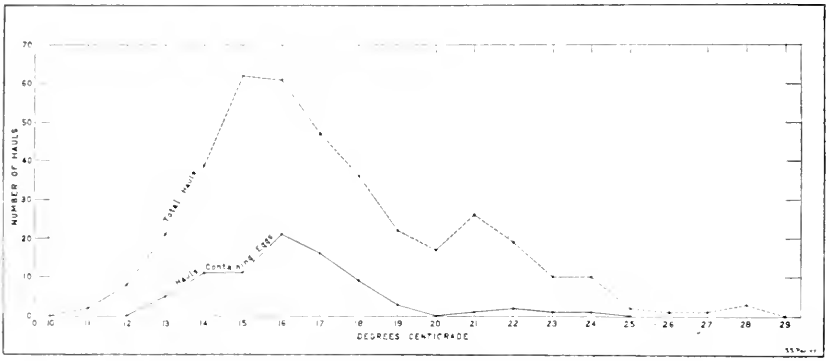

FIG. 11. Graph showing the total number of hauls made at each temperature and the number of hauls which contained sardine eggs.

The data for all hauls from California and Mexican waters, from the investigations by E. C. Scofield from 1929 to 1932 and by the writer during 1936, have been combined in figure 11, showing the total hauls made and the number of hauls which contained sardine eggs. These data show that:

1. No temperatures were encountered below 11° or above 28° C.

2. One-half of the hauls were made at temperatures between 15° and 18°.

3. No eggs were encountered below 13°.

4. The maximum number of hauls containing eggs was at 16°.

5. One-half of the hauls that contained eggs were made at temperatures between 15° and 18° C. We may conclude that this range represents the optimum temperature for sardine spawning.

In figure 12 the data for California and Mexico have been separated. Hauls made below Point Descanso (about half way between San Diego and Ensenada) were considered as being off Mexico, and those made above were considered as being off California. This division

affords a more reasonable boundary for the purpose at hand than the political line. Two facts are evident—temperatures in Mexican waters are higher than those in California, and it naturally follows that the main spawning takes place at a higher temperature in Mexico than in California.

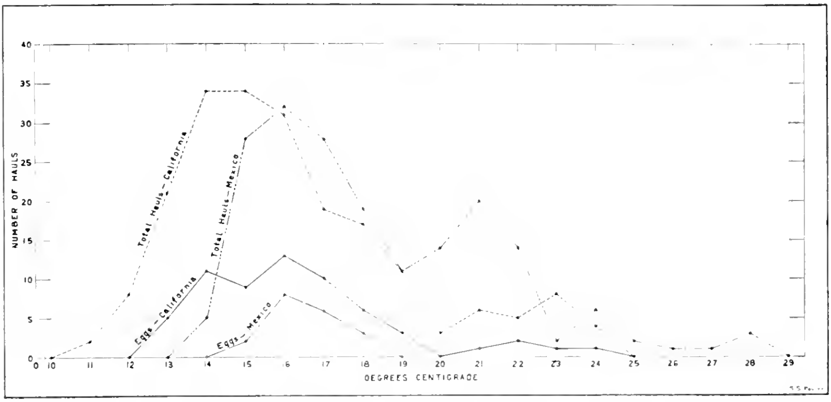

FIG. 12. Graph showing the relation between the total number of hauls made in California waters and in Mexico, and the number of hauls in those localities which contained sardine eggs.

Eggs taken in California at 21°, 22°, 23°, and 24° were all caught within the region of maximum spawning off the southern California coast during 1931, the year of unusually high surface temperatures.

Figure 13 is a graphic representation of the average monthly surface temperatures at four localities from 1926 to 1933: San Francisco (North Farallon Island), Monterey (at shore off Pacific Grove), Hueneme (pier), and San Diego (Scripps Institution of Oceanography

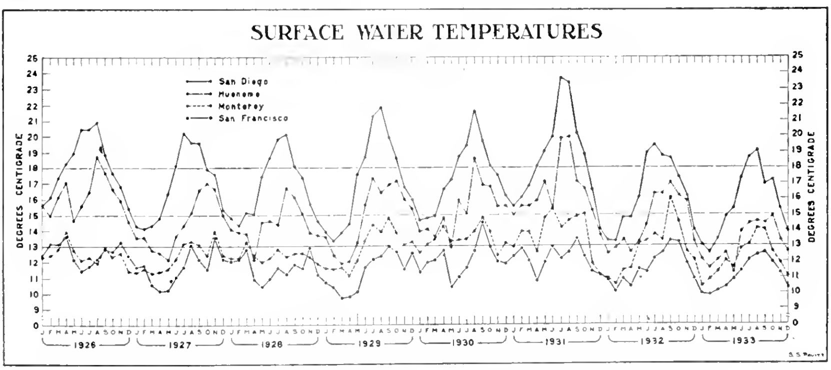

FIG. 13. Surface water temperatures at San Diego, Hueneme, Monterey and San Francisco, 1926–1933. The solid line at 13° represents the lowest temperature at which sardine eggs have been taken, most of the eggs have been taken between 15° and 18°, as represented by the two broken lines.

pier, La Jolla). These temperature records have been made available to us through the courtesy of the Scripps Institution of Oceanography. The line extending across the graph at 13° represents the lowest temperature at which sardine eggs have been taken, and the two broken

lines represent the upper and lower limits of the range in which 50 per cent of the hauls containing eggs were taken, or in other words the optimum range for sardine spawning.

This figure shows that the temperature off San Francisco seldom exceeded 13°, or the lower limit of spawning, and never extended into the optimum temperature range. Monterey is a little better in this respect: the temperatures were consistently a few degrees higher than at San Francisco. The characteristics of the curve for Hueneme indicate that this region (or regions which have similar temperatures) is the one most favorable for sardine spawning. This is in exact agreement with observed conditions. In the San Diego region the temperatures run, if anything, too high. This again is in agreement with our observations, as San Diego is approximately at the lower edge of the region of maximum spawning.

The surface temperatures along the west coast of Lower California are such that spawning may take place. In 1936 a fairly heavy spawning was found in the Viscaino Bay region and it is of great importance to establish whether or not this region contributes to the sardine population of the coast of California. Three main lines of study are here involved:

1. An investigation into surface current phenomena and the occurrence and distribution of sardine larvae and young fish to discover if the larvae from Mexico do or do not mingle with those from California.

2. Tagging experiments to show whether or not the sardines of Lower California and those of California constitute a single population and migrate from one region to the other.

3. A series of quantitative plankton investigations to determine the relative abundance of sardine eggs and larvae in the two regions.

The possibility has been suggested that there is an abundant spawning in the warm California Current which runs parallel to the coast of California and some distance offshore. This is based on the fact that surface temperatures in that current lie within the range favorable for sardine spawning. On the basis of temperature alone one would expect that spawning might take place in the California Current. This was found to be the case, but it is remarkable that the number of eggs was very much smaller in the region north of Point Conception as compared with that in more southerly waters. A very sharp dividing line is manifest in that eggs north of Point Conception were present in numbers not exceeding, at the most, a few hundreds, whereas south of that region identical hauls revealed thousands. The reasons for this phenomenon are not readily apparent, but this much is indicated—that factors will very possibly be found which, in spite of favorable temperature conditions, determine the scarcity of sardine eggs and larvae to the north.

The data for the California Current are incomplete and a program is under consideration which will, if carried through, establish whether or not the California Current is important as a spawning ground for the sardine. The same general problems are here involved as have been stated for the investigation on Lower California, and more information must be made available before a satisfactory answer may be found. Positive evidence, incomplete as it is, however, indicates that the spawning in the California Current north of Point Conception is of minor importance. There is no foundation in fact, as far as present

data show, for the assumption that an abundant spawning takes place in that region.

Summary

1. There is a temperature threshold below which metabolic activities are at so low a level that the gonads do not develop and spawning will not take place.
2. There exists a definite relationship between surface water temperatures and the extent and abundance of sardine spawning.
3. The minimum temperature at which spawning will take place is approximately 13° C.
4. The optimum temperature is between 15° and 18°.
5. Spawning may not be expected inshore in the San Francisco region or farther north, with the possible exception of an occasional fortuitous spawning of very minor importance in years of unusually high surface temperatures.
6. Occasional inshore spawnings may take place at Monterey, more often than at San Francisco, but will not be frequent enough or large enough to make any material contribution to the general sardine population.
7. Temperature conditions in the California Current are favorable for sardine spawning but eggs and larvae have not been found in any numbers in this current north of Point Conception. The reason for this is not clear but it is indicated that other factors may be involved which determine this scarcity.

LITERATURE CITED

Clark, Frances N.
1934. Maturity of the California sardine (*Sardina caerulea*), determined by ova diameter measurements. Calif. Div. Fish and Game, Fish Bull., no. 42, 49 pp.

Hjort, Johan
1910. Report on herring-investigations until January 1910. Cons. Perm. Int. Explor. Mer, Publ. Circ., no. 53, 174 pp.

Lea, Einar
1913. Further studies concerning the methods of calculating the growth of herrings. Cons. Perm. Int. Explor. Mer, Publ. Circ., no. 66, 35 pp.

Nilsson, David
1914. A contribution to the biology of the mackerel; investigations in Swedish waters. Cons. Perm. Int. Explor. Mer, Publ. Circ., no. 69, 61 pp.

Orton, J. H.
1920. Sea-temperature, breeding and distribution in marine animals. Mar. Biol. Assn., Journ., n.s., vol. 12, no. 2, pp. 339-366.

Scofield, Eugene C.
1934. Early life history of the California sardine (*Sardina caerulea*), with special reference to distribution of eggs and larvae. Calif. Div. Fish and Game, Fish Bull., no. 41, 48 pp.

Schmidt, Johs.
1909. The distribution of the pelagic fry and the spawning regions of the gadoids in the North Atlantic from Iceland to Spain, based chiefly on Danish investigations. Cons. Perm. Int. Explor. Mer, Rapp. Proc.-Verb., vol. 10, no. 4, 229 pp.

PROGRESS REPORT OF TROUT FEEDING EXPERIMENTS, 1936[1]

By J. H. WALES AND RICHARD BLISS
Bureau of Fish Conservation
Division of Fish and Game

It has been the aim of the Mt. Shasta Experimental Trout Hatchery to run tests on various foods and to perfect feeding methods in an entirely practical manner. Large groups of fish are used and their care is the same as in the producing hatchery. This policy has been followed so that the results when found to be good can be put into immediate use.

The following were the principal objectives in the 1936 set of experiments: (1) to test the value of dehydrated beef meal as a trout food, and (2) to determine the effectiveness of feeding meals mixed with liver as compared to feeding the meals separately.

Description of Experimental Fish and Their Care

The fish used were brook trout (*Salvelinus fontinalis*) from eggs shipped to Mt. Shasta from Colorado. They were from unselected fish. The eggs were 415 per ounce in size. About 24,000 eggs were placed in each of 14 baskets. Hatching was completed on January 25, 1936. On February 8, when the fish started to feed, 23,000 were put in each trough. All of the troughs were given identical care except for the differences in diet and in feeding methods. To prevent overcrowding, the fish were thinned down to 300 ounces per trough on May 25, and on July 8 were thinned to 400 ounces. Due to an epizootic of furunculosis and our inability to buy more meat meal from the manufacturers, the experimental diets were discontinued after August 1. The fish were kept, however, to ascertain their comparative resistance to the disease.

One hundred or more fingerlings in each trough were weighed at the start of feeding and at biweekly intervals thereafter. A record was kept of the weight of the food fed during the experiments. The losses in each trough were recorded. The water temperatures ranged between 40° and 56° F.

Description of Foods

Beef liver and beef heart: These were fed while fresh. Cost of liver was 16c per lb. Cost of heart was 9c per lb.

Salmon egg meal: The cost of this was 7c per lb.

Dry skim milk: This was an insoluble feed grade and cost 5.1c per lb.

[1]This is the third report of experiments which are being conducted at the California Division of Fish and Game Experimental Trout Hatchery located at Mt. Shasta; submitted for publication, February, 1937. See also previous reports published in *California Fish and Game*: vol. 21, no. 2, pp. 110-124, 1935; vol. 22, no. 2, pp. 111-117 (figures on pp. 105-110), 1936.

Dehydrated beef meal: This was purchased in San Francisco at 3.5c per lb. At present this meal is not being manufactured in the west.

Salmon meal: This was purchased at 3.5c per lb.

Wheat middlings: The cost was 2c per lb.

Preparation of Food and Feeding

Finely ground beef heart was fed to all the experimental groups for the first seven weeks. Then, when they averaged about 150 fish per ounce, the feeding of liver and meals was started. Groups 1, 3, 5 and 6 were fed the meals mixed with the liver in the same manner used in the last two years, *i. e.,* the desired amounts of finely ground liver, meals and water were thoroughly mixed by hand, then ground through a meat grinder. This mixture was allowed to stand for two hours or more and was then fed through the regulation perforated bottom dippers. Groups 2 and 4 were fed the same foods as 1 and 3 but the ingredients were presented to the fish in a different manner. The liver was fed through a perforated bottom dipper once a day (in this case the noon feed) and the meals were fed in the morning and afternoon. When fish are as small as 150 per ounce it is difficult to prepare the meals so that they can be fed alone without having them break up and be lost in the water. The writers had fair success making the combination of meals slightly moist and then stirring them until the particles had clumped together, remotely resembling cottage cheese. This could be scattered to the fish by shaking it through a screen bottom dipper or by throwing it with the hand. These clumps of particles or curds could be broken up by the fish very easily and the amount of pollution was kept at a minimum.

However, the efficiency of this method does not seem to be as great as in the usual method where the meals are mixed with the liver. With our grinder it was impossible to start feeding pellets until the fish were at a size of 25 per ounce. These pellets were made by moistening the meals as in the previous method, then grinding them through the plate with the smallest holes (in this case 5/64 inch). The resulting spaghetti-like strings were allowed to stand until they could be broken by hand into short lengths. These pellets were fed twice a day and straight liver once daily to groups 2 and 4. The results were excellent, growth was good, the cost was low, there was less pollution of the water, and the fish could be fed in this manner more quickly and easily than when the meals are mixed with the liver. The pellets often fall to the bottom of the trough too rapidly for the fish to catch them but they are picked up and very little is wasted. If the fish are in ponds, the greater depth of the water allows more time to catch the pellets before touching the bottom. All trout from about 25 per ounce (400 per pound) on up can be fed pellets, the size of which can be varied to suit the fish. Most of the usual fish foods can be made into pellets although some ingredients such as raw wheat middlings make the small pellets too sticky. Some experience is necessary in order to get the correct amount of moisture in the mixture to be formed into pellets. The larger the pellets, the more moisture they will stand without becoming sticky. There is a limit to the amount of liver which can be incorporated in

the smallest pellets. The writers' experience shows this level to be less than 20 per cent by weight as fed. In other words, when making pellets for fish between the sizes of 25 and 2 per ounce, it was necessary to mix 80 ounces of dry meals with 20 or less ounces of liver in order that the pellets do not become too sticky and thus fail to separate. A major difficulty in the production of pellet type trout food lies in the grinder. The writers feel that they have yet to use a good grinder for this purpose. A grinder suitable for liver may be and usually is far too weak for pellet manufacture. Some sort of large, powerful, direct drive assembly can probably be purchased. In addition to the grinder, various sorts of food mixers could be employed to prepare the food for grinding. However, this task can be done by hand without too much labor.

For the benefit of those who have not used pellets for fingerlings and adult trout the foregoing discussion might well be summarized.

1. Pellets may be composed of dry meals entirely or a combination of dry meals and fresh meat.

2. The size of the pellets may be varied by the use of different sized grinder plates.

3. The food to be made into pellets must be relatively dry. If meals alone are to be used they can be dampened but slightly, and if small pellets are to be made of a combination of meals and liver the amount of liver should not exceed 20 per cent by weight of pellets.

4. The larger the plate used the greater can be the amount of moisture in the food.

5. Pellets suitable for small fish (25-2 per ounce) can not incorporate enough fresh meat, so it is necessary to feed straight meat occasionally. Pellets suitable for adult trout, made with a half-inch plate, can incorporate enough fresh meat to be fed exclusively.

6. To make pellets one mixes the ingredients thoroughly and grinds them through the appropriate plate. The resulting spaghetti-like strands are then broken into short lengths and the food is ready to use.

In addition to this method of preparing the pellets we can recommend a feeding program as follows:

1. Finely ground heart for the first 4-8 weeks.

2. 50 per cent liver and 50 per cent meals by weight, mixed together and fed through a perforated dipper until the fish average 25 per ounce.

3. Pellets made of meals alone twice a day and liver fed through a perforated dipper once a day until fish are 2 per ounce.

4. From the time the fish are about 2 per ounce they may be fed pellets containing meals and approximately 20 per cent liver by weight as fed. The size of the plate used for manufacturing the pellets varies from 5/64-inch on up as the fish grow.

This procedure might seem to be too complicated and to require extra labor but this is not the case. In fact, one can feed in less time and with less labor by this method when equipped with the proper meal bins, mixing machine and grinder. The expense of installing the correct machinery is easily balanced by the lowered cost of food, ease of feeding and the smaller amount of pollution in the water.

Mortality

The health of the fish was as good as could be expected until the furunculosis started. The loss was never more than the average for a producing hatchery. The best results of the six different groups were in the fish that were fed liver, salmon egg and meat meal mixed together. The mortality rates in all groups can be seen in the table.

It was thought that the addition of raw wheat middlings to a diet might be of interest as this practice is not uncommon. We have shown that the presence of the middlings is of no great importance although the mortality and cost were both relatively high.

Furunculosis was to be found in the eastern brook trout brood stock at Shasta and undoubtedly the experimental fish took it from them. The fish started to die from furunculosis on July 22 and by August 12 all groups had become infected. The greatest daily loss for the entire lot occurred on August 18, about seventeen days after the average beginning. The end of the epizootic occurred in all groups between September 11 and October 26. The average time for the disease to end occurred on September 23, or about eight weeks after the epizootic started. During this period approximately 92 per cent of the fish were killed by furunculosis and *Chloromyxum* in the kidneys. This latter disease became noticeable toward the end of the epizootic and caused an appreciable part of the deaths. The external symptoms of these two diseases are usually alike except when boils are present in furunculosis so it was impossible to tell just what percentages can be assigned to each disease. Nevertheless, it is certain that furunculosis was much more important than the *Chloromyxum*. The characteristics of the furunculosis were about average. The percentage with external boils was small. The fish which were badly affected with *Chloromyxum*, probably *C. truttae*, differed from those dying from furunculosis in the appearance of the kidneys which were considerably swollen and of a gray-red color.

The effect of diet upon the presence and severity of the diseases was very confusing. No clear-cut correlation could be seen. The fish that were fed with the diet (No. 1) of liver, salmon egg and meat meal had the lowest mortality before the epizootic began, and then suffered most from furunculosis. Each diet group was made up of two troughs, the lower trough receiving its water from the upper. One would expect to see some correlation between the two troughs of such a combination but this was not the case. The upper trough of group 4 showed the disease five days before the lower did, while the upper trough of group 6 showed the disease 16 days after the lower. The disease was more severe in the lower trough of group 4, whereas it was less severe in the lowers of groups 5 and 6. The lower trough of group 4 suffered much more than the lower in group 5. This lack of correlation persisted throughout the entire hatchery. The only positive thing we can say is that no conclusions can be drawn on the effect of diet on furunculosis. It is also evident that if we had not been using large groups of fish, with each group composed of two troughs, we might easily have come to erroneous conclusions or to conclusions which can not now be made.

One should not get the impression from the foregoing discussion that diet has no influence on the resistance of trout to furunculosis. On the contrary, it is probable that diet does play quite an important role. However, the diets used in these experiments were quite similar in respect to their basic ingredients, and for this reason the effect upon disease was about the same in all. The experiments were not designed to elucidate the effect of certain foods upon resistance to furunculosis. If experiments were undertaken to determine the elements most important in bringing about resistance, a simple basic diet would be fed to all groups and mineral, vitamin and probably other modifications made to certain groups. The number of fish used in each group should be as large as possible. Experiments of this sort should be undertaken by a number of investigators working under dissimilar conditions.

Growth

Growth was reasonably good in all the groups. Differences might have become apparent if the tests could have been continued, but due to the outbreak of furunculosis our growth comparisons end at the first of August, less than six months after feeding began. The lack of variation in growth might be partially explained by the fact that we fed a relatively high percentage of liver in all diets. This liver percentage might tend to compensate for slight inequalities in the meals. We fed such a high liver percentage (55–58 per cent by weight, as fed) for entirely practical reasons. In one case where the liver and meals were mixed together and fed by dipper, 58 per cent of liver was necessary to give the proper consistency to prevent undue pollution of the water. In the case where the liver and meals were fed separately, 55 per cent by weight of the day's food made just enough liver for one feed. It would have been possible to reduce this quantity of liver if we had not been comparing two methods of feeding the same food.

We feel sure that meat meal, when it can be obtained, is an excellent trout food and can be placed in the same category as salmon egg and dry milk as excellent fresh meat substitutes.

Cost

The only important point brought out by these experiments is that the cost of feeding trout fingerlings is less when the meals of a liver-meal diet are fed in pellet form than when the liver is mixed with the meals and the combination fed through a perforated bottom dipper. This seems to be due to two facts: First, that when the meals were fed in pellet form less liver was fed and the cost reduced accordingly, and, second, that the consumption of the meals in pellet form is more efficient. There is likely to be considerable waste of meals through separation into the water when the meals are fed mixed with the liver.

Summary

1. Eastern brook trout fingerlings were used in feeding experiments to determine the value of dehydrated beef meal as a trout food, and to compare the efficiency of feeding meals mixed with liver and meals in pellet form fed separate from the liver.

2. It was determined that dehydrated beef meal, when it can be purchased, is a valuable trout food, comparing favorably with salmon egg meal and dry skim milk.

3. It was found that meals can be prepared in pellet form and fed to trout which are larger than 25 per ounce. When the meals are thus fed separately from liver it is more efficient, easier and cleaner than when the meals are mixed with the liver and fed through a perforated bottom dipper in the usual manner. Especially is this true when the fish are kept in raceways and ponds.

TABLE 1

DESCRIPTION OF EXPERIMENTAL GROUPS, 1936

Group	Species	Number of fish at start	Percentages of foods are by weight as fed	Method of feeding
1	Brook trout	46,000	Liver 58% plus salmon egg 21% plus meat meal 21%	Liver and meals mixed.
2	Brook trout	46,000	Liver 55% plus salmon egg 22.5% plus meat meal 22.5%	Liver once a day; meal pellets twice a day.
3	Brook trout	46,000	Liver 58% plus dry milk 21% plus meat meal 21%	Liver and meals mixed.
4	Brook trout	46,000	Liver 55% plus dry milk 22.5% plus meat meal 22.5%	Liver once a day; meal pellets twice a day.
5	Brook trout	46,000	Liver 58% plus salmon meal 21% plus meat meal 21%	Liver and meals mixed.
6	Brook trout	46,000	Liver 58% plus salmon egg 14% plus meat meal 14% plus wheat middlings 14%	Liver and meals mixed.

TABLE 2

SUMMARY OF RESULTS OF 1936 TROUT FEEDING EXPERIMENTS

Group	Pounds of food as fed to produce a pound of trout	Pounds of food dry weight to produce a pound of trout	Cost of food to produce a pound of trout	Cost per 1,000 fish	Number of fish per ounce at end of experiment	Pounds of fish produced	Total mortality of fingerlings, Feb. 13-July 31	Percentage of mortality of fingerlings	Percentage of mortality of fry
1	2.53	1.37	$0.32	$2.09	9.6	152	1,892	3.80	1.40
2	2.40	1.39	.29	1.78	10.2	150	2,474	5.02	1.65
3	3.05	1.64	.38	1.62	14.5	126	2,181	4.77	1.45
4	2.32	1.34	.27	1.77	9.6	156	2,506	5.40	1.70
5	2.79	1.50	.33	1.64	12.7	138	2,432	4.93	1.75
6	2.98	1.90	.37	1.84	12.3	129	3,064	6.16	2.05

SESTONOSIS, A GILL IRRITATION IN TROUT [1]

By J. H. WALES AND DONALD EVINS
Bureau of Fish Conservation
Division of Fish and Game

The disease reported in this paper is caused by certain kinds of foreign matter in the water, which irritate the gills, and is not brought about by a specific organism. It is felt that this disease is more widespread than previously believed. So far as is known young fingerlings are the only trout to be affected and some strains are more susceptible than others.

The majority of the fish hatched and reared to planting size at the Lake Almanor Hatchery, where the disease is prevalent, are rainbow trout from eggs collected at various stations on streams tributary to the lake. These fish develop a serious gill disease each year about two weeks after feeding has started. Brook trout fingerlings are also troubled by the disease, but not the brown trout or salmon. The external symptoms are not unlike those in other forms of gill disease or in Octomitiasis. The fish lose their appetites and become so emaciated and weak that they lose their equilibrium and are washed down against the end screen. Losses from this disease reach figures high enough to make it one of the principal causes of trout mortality in the State. After much study, it was concluded that no single organism was responsible, nor was food pollution to be suspected. Nearly every dead and dying fingerling had a relatively large mass of foreign matter and mucus lying on the base of the tongue and fastened to the gill arches. This was apparently making it difficult for the fish to eat and to breathe. In addition, the gill filaments were badly swollen and could not properly absorb oxygen.

The Lake Almanor Hatchery takes its water from Clear Creek which is composed of the water from several springs. These springs flow from a lava bluff into a meadow where they form a broad shallow stream heavily grown with various flowering aquatic plants and algae. This portion of the stream is about one-half mile long and the hatchery intake is situated at the lower end before the stream assumes a narrower, swifter character. As the name of the creek implies, the water is apparently free from foreign matter during the major part of the year. However, with a plankton net one can collect 0.36 cc. of plankton per 100 gallons of the water as it enters the hatchery troughs. The plankton is composed of a variety of diatoms and other small algal forms, together with a small number of protozoa and bacteria.

The following experiments were conducted to test the theory of gill irritation and weak strains of fish: We hatched and reared rainbow from the Klamath River, Big Creek and Lake Almanor strains at

[1] Submitted for publication, February, 1937.

both the Almanor and Mt. Shasta hatcheries. These strains were represented by 25,000 to 50,000 fingerlings. These numbers we felt were sufficiently large to avoid error. In addition to these large scale experiments we held two smaller lots of Almanor rainbow at the Lake Almanor Hatchery. Each of these contained 5,000 fish and were kept in comparable portions of two troughs. One of these groups of 5,000 fish was supplied with the regular hatchery water and the other group was supplied with water taken directly from one of the springs before it entered the large shallow algae-filled portion of the stream mentioned previously. The pure spring water was supplied from a domestic water line. This supply of water contained but a small quantity of foreign matter. All of the groups were given similar care. The food was 100 per cent beef liver. The dead fish were counted daily at Mt. Shasta and in the small scale groups at Lake Almanor. The experiments were continued until well past the period of gill disease.

The results are as follows: The three strains at Mt. Shasta showed less difference in growth and health than those at the Almanor Hatchery, however, the Klamath River fish were the healthiest and grew fastest while the Almanor fish suffered the most from the gill disease and consequently grew slowest. The Big Creek fish suffered slightly less than the Almanor fish. At the end of the experiment at Mt. Shasta the weights and mortalities were as follows:

	No. of fish per oz. at end of experiment	*Percentage of mortality*
Almanor fish	49	22
Big Creek fish	40	21
Klamath River fish	35	7

The disease appeared in the fingerlings at Mt. Shasta approximately two weeks after feeding commenced and was similar in other respects to its manifestation at Lake Almanor. The amount of detritus in the Mt. Shasta water was high but contained more decaying vegetable matter and less diatoms, algae, bacteria, and protozoa.

At the Lake Almanor Hatchery the results were more striking. The Klamath River fish suffered very little from the disease whereas the Almanor and Big Creek fish were seriously affected. The three different strains hatched at such widely separated dates, and the data on weights and mortality were so fragmentary that it is impossible to give definite figures on the large groups. However, the growth was most rapid in the Klamath strain and these fish did not contract the gill disease. The Big Creek and Almanor rainbow grew slowly and suffered considerable losses.

The two small groups of Almanor rainbow, one of which was supplied with regular hatchery water and the other with the pure spring water had remarkably different growth and mortality rates.

	No. of fish per oz. at end of experiment	*Percentage of mortality*
5,000 Almanor rainbow trout kept in regular (polluted) hatchery water	84	61
5,000 Almanor rainbow trout kept in pure spring water	65	8

As the above figures show, the gill disease appeared only in the fish kept in the polluted water and growth was correspondingly retarded.

There seems to be little doubt that certain kinds of foreign matter in hatchery waters are more injurious than others. Inorganic sediments are usually not as harmful as organic material, and living organisms such as diatoms, filamentous algae, bacteria and protozoa are by far the most harmful.

It seems quite evident from these experiments that certain wild strains of trout are more easily affected by irritants in the water than others. Just why this should be so is not clear but the difference in resistance might have been brought about by natural selection in the native waters of these particular strains of rainbow. The Klamath River strain is native to a water which is highly charged with planktonic algae and it seems probable that the fish have become resistant to this form of gill irritation. The Almanor and Big Creek strains are native to waters comparatively free from pollution of this type.

In conclusion we can say that two factors are active in this particular gill disease. In the first place certain hatchery waters are polluted by diatoms, other small algal forms, bacteria and protozoa. This foreign matter is very injurious, mechanically, to the gills of certain strains of trout. In the second place certain strains of trout are more easily injured than others by the above-mentioned foreign matter. Therefore when a susceptible strain of trout is reared in this type of polluted water the gills become irritated to such an extent that heavy losses are suffered within a few weeks after feeding starts.

The solution to the problem at the Almanor Hatchery would be an intake pipe line which would bring water from one of the springs at the head of the stream rather than from the lower end of the shallow algae-filled section. A filter, if properly constructed, might serve the purpose but would be much more troublesome.

Occasionally it might be possible to rear the susceptible strains of trout in hatcheries having pure water and the hardy strains in polluted water.

We propose the name Sestonosis for this type of gill disease. The term *Seston* designates the mixture of living and nonliving bodies which float in water. The ending *-osis* indicates a disease.

THE RELATIVE SUSCEPTIBILITY OF VARIOUS STRAINS OF TROUT TO FURUNCULOSIS[1]

By J. H. WALES AND WILLIAM BERRIAN
Bureau of Fish Conservation
Division of Fish and Game

In several outbreaks of furunculosis in California it appeared that all of the exposed species of trout fingerlings were not equally susceptible to the disease. The question then arose, whether the various strains of the bacteria might differ in their virulence for any one species of trout. In an attempt to answer this question we subjected brook trout, brown trout, silver salmon, and two strains of steelhead trout fingerlings to a single strain of furunculosis and noted the ensuing mortality.

The following fish were placed together in a suitably large rectangular pond in July, 1936. The water temperature varied from 43° to 70° F., with an average of about 58°. The food was 100 per cent beef heart.

Species	*No.*	*No. fish per oz.*	*Source of eggs*
Brook trout	2,500	6.0	Mt. Whitney Hatchery, Calif.
Brown trout	2,500	6.4	Mt. Shasta Hatchery, Calif.
Steelhead trout	2,500	12.0	Scott Creek Egg Station, Calif.
Silver Salmon	2,500	6.0	Scott Creek Egg Station, Calif.
Steelhead trout*	11,600	60.0	Klamath River Egg Station, Calif.

* These were placed in a circular pond.

On July 20 and on August 4, all of the fish were given furunculosis bacteria in the food. These bacteria had been in culture media for several weeks and were presumably weakened to a point where it was impossible for the disease to infect the fish. Therefore, on August 14 another strain of furunculosis was placed in the food. This culture was made from the epizootic in the Mt. Shasta experimental eastern brook trout.[2] On August 22, eight days after the last introduction of the bacteria the silver salmon, brown trout and brook trout showed the disease. On August 29 the steelhead contracted the disease, fifteen days after its introduction. The steelhead in the circular pond did not show symptoms of furunculosis until September 16, 34 days after the last introduction of the bacteria. At this time they weighed 15 per ounce. The course of the disease in all species ran much the same. Its progress was slow for a few days, then there was a sudden flare-up for five to ten days, followed by an equally sudden decrease and a long period when losses were slight. The entire

[1] Submitted for publication, February, 1937.
[2] See "Progress report of trout feeding experiments, 1936," pp. 138-143, of this issue.

course of the disease ran approximately 70 days, during which time the percentage losses, presumably from furunculosis, were as follows:

Brook trout	98%
Silver salmon	92%
Scott Creek steelhead	82%
Klamath steelhead	64%
Brown trout	50%

Fin-rot was present to some extent in all the groups. The degree to which the species were affected by this disease is shown in the following list, the steelhead suffering most:

1. Klamath steelhead
2. Brook trout
3. Scott Creek steelhead
4. Brown trout
5. Silver salmon

The bearing which fin-rot may have had on furunculosis is not clear, but it is more than probable that it predisposes the fish to furunculosis, either by producing lesions through which furunculosis bacteria can enter the fish, or by generally weakening their resistance. Both of these factors may be partially responsible for the apparent relationship. It is quite obvious that cases of fin-rot should be cured by appropriate treatments as early as possible in order to reduce the chances of contracting furunculosis.

It is interesting to note the location of furunculosis boils in the various species. The following list gives the average or usual position only:

Brook trout	near dorsal fin
Brown trout	on belly
Klamath steelhead	near dorsal fin and on belly
Scott Creek steelhead	near dorsal fin and on sides
Silver salmon	on top of head

In conclusion, we can say that all of the species of trout and salmon used in this experiment were susceptible to one strain of furunculosis which came originally from brook trout fingerlings. They were not equally susceptible, but further tests would be necessary to determine whether this was an inherent difference or due to age, fin-rot or some other predisposing influence. However, we have good reason to believe that if one species in a hatchery contracts the disease other species may also become infected.

NOTES ON THE FOOD OF TROUT OF YOSEMITE NATIONAL PARK

By H. JOHN RAYNER [1]

In the interests of the many nature lovers and sportsmen who annually visit Yosemite National Park, and to further the knowledge of the food of trout, the following results of a study of the contents of the stomachs of trout from many regions of the park are submitted.[2]

Specimens were collected for the most part with the aid of artificial dry flies at altitudes ranging from 3,000 to 10,900 feet, in streams, rivers and lakes during the summer of 1936. Mr. Hamilton MacCaughey supplied most of the trout not taken by the author. A few trout were sent in by various fishermen. The writer was stationed on the floor of Yosemite Valley and at Tuolumne Meadows. The environs of these two places supplied all of the trout examined except for six golden trout from a small unnamed lake just outside of the park boundary on the eastern slope of Mt. Conness.

The species of trout concerned in the study were the rainbow (*Salmo irideus*), cut-throat or black-spotted (*Salmo henshawi*), eastern brook or speckled (*Salvelinus fontinalis*), golden (*Salmo aqua-bonita*) and the Loch Leven or brown trout (*Salmo levenensis*).

A student of the ecology of fishes must consider food as an important factor in life conditions. The trout is a fish of diverse food habits, and this fact is borne out by the results of studies made of trout stomach contents in many regions of the United States and of the world. Since the fauna of waters and the food of trout inhabiting those waters may well be known by an examination of the stomach contents of the trout, this method has formed the basis of this paper.

The Class Insecta (insects) includes some of the finest kinds of trout food. The Orders of Trichoptera (caddis flies, caddis worms, case or stick worms, or periwinkles), Plecoptera (salmon or stone flies), Ephemeroptera (mayflies), Neuroptera (hellgrammites, alder, orl and fish flies), and Diptera (true flies, of the group known as midges) are most important in the diet of trout, and form, in general, the bulk of the food consumed of nutritive value. For illustrations and descriptions of the commoner forms mentioned here, see the references cited in the bibliography.

The food of trout may be divided into that which is terrestrial in origin and that of aquatic origin. Food of terrestrial origin may include beetles, ants, bees and wasps, leafhoppers, grasshoppers, true flies, true bugs (Hemiptera), and the adults of some aquatic forms which have

---

[1] Mr. Rayner, a graduate student at Cornell University when he prepared this paper, is now affiliated with the U. S. Bureau of Fisheries as Special Scientific Assistant in The California Trout Investigations.

[2] The writer wishes to express thanks to Prof. W. B. Herms of the Department of Entomology of the University of California for the use of a microscope; to Messrs. C. A. Harwell and J. E. Cole of the U. S. Department of Interior for the loan of field equipment and laboratory space in the Yosemite Museum; and to Mr. H. H. Hoss for valuable assistance in accommodation arrangement.

emerged from the water and later fallen back. Food of aquatic origin may comprise the larval, nymphal or pupal forms of stone flies, caddis flies, mayflies, orl flies and midges, among other things.

The surface food is important only during the spring and summer months, and to complete a study of this sort, the winter food should be known. The data here given present a picture of the food taken at a given date and do not consider the food for the remainder of the year. Where the winter temperatures drop to near the freezing point, studies have shown that trout take little or no food. For example, in some hatcheries where low temperatures exist during the winter months, trout eat very little.

Many of the insects found in the stomachs were tried as lures for trout. Of these, the nymphs or adults of stone flies (Plecoptera) were by far the most attractive. The nymphs may be found by turning over large and small rocks in streams or in trash such as may collect in an eddy. The adults may be taken from vegetation on the stream and river banks, or they may be found emerging at dusk or shortly thereafter. With the aid of a light they may be found on the emergent rocks in the water or on the rocks and vegetation of the bank. Where other baits failed entirely, the stone flies were found to be successful as either floating or sunken lures in swift or quiet waters. The larger species, of one to one and one-half inches in length, were the most attractive to trout.

In the various streams and lakes as a whole, no one type of food was found to be dominant, but in a given area, the writer often noted a single group to be of primary importance. At the lower altitudes (3,500 to 4,000 feet), in streams and rivers, net-winged midges (true flies) and caddis flies were predominant. At higher altitudes (7,000 feet), in the streams, surface food of all kinds, particularly beetles, was of most importance, and caddis flies were again numerous. In the streams at 8,000 to 10,500 feet, stone flies were of greatest importance and again the caddis flies were high in number. Ants were present in varying numbers in nearly all the stomachs from streams. A seasonal study of these streams at different altitudes might reveal different results. Altitude may govern temperature and this factor may therefore determine the times of emergence of many aquatic and terrestrial insects.

Fish in any given lake were found to take much the same food, but this may vary as the depth changes, as streams enter, and as the vegetation at the water's edge changes. In lakes the food tended to become more homogeneous than in streams and rivers; it consisted largely of midges (Chironomidae; a family of the true flies, whose larvae are often called "bloodworms") and water mites (Hydrachnidae; minute animals, closely related to insects).

The reader may wonder if the food of this region differs from that of other areas where studies of similar nature have been made. In the lakes no scuds were in evidence, and one other member of the Crustacea was present in only one lake. Observations made at Hot Creek, California, by Paul R. Needham, proved scuds to be an important article of diet. Chancey Juday found Crustacea to be dominant in some Colorado lakes. In the higher lakes of the Colorado-Wyoming district, J. W. Scott found Crustacea to be important, and Dimick and

Mote have shown that "fresh-water shrimps (scuds) are important items in the diet of Oregon trout in lakes * * *." Midges have been reported (Paul R. Needham) as important in the lakes of the Sierra Nevada, and this is verified in the results obtained by the writer.

Altitude, bank and shore vegetation, type of bottom, stream or lake, season, and the availability and kinds of food present, largely determine the food taken.

Tables 1 to 6 are concerned with food of trout in lakes. In table 1 it is shown that there was little variation in the kinds of food taken by various individual trout in Upper Fletcher Lake at the time of the study, i. e., only certain representatives of any one food group are present. In no other area studied was there such a uniformity in so many food groups, even though this body of water is similar to many of the higher lakes of the region. A marked paucity of other forms is thus indicated.

In table 2 it is shown that aquatic true flies are of great importance. Almost without exception, the food was of aquatic forms. The diet of the golden trout in this lake differs from that of the same species in Upper Fletcher Lake; the factors governing this difference may be availability and amount of food.

In table 3 is given the food consumed by a single golden trout. All foods taken by this trout are forms that have an aquatic existence.

TABLE 1

Foods Consumed by 14 Golden Trout from Upper Fletcher Lake. Elevation, 10,400 feet.
Fish taken August 25, 1936; average length, 9 inches; maximum, 13 inches; minimum, 6.8 inches.

Class of food	*No. found in all stomachs*	*Average percentage in stomachs by estimated volume*
Caddis flies (one species)	20	10
True bugs (two species)	3	2
Beetles (two species)	68	23
Mayflies	2	Less than 1
True flies (midges alone)	190	39
Water mites	42	7
Leafhoppers (one species)	20	6
Ants and wasps	45	12

TABLE 2

Foods Consumed by Six Golden Trout from a Small Unnamed Lake on Eastern Slope of Mt. Conness. Elevation, 10,300 Feet.
Fish taken August 6, 1936; average length, 6 inches.

Class of food	*No. found in all stomachs*	*Average estimated percentage in all stomachs*
True flies (midges)	280	90
Caddis flies	13	10
Aphid	1	Less than 0.1 of 1%

TABLE 3

Food of One Golden Trout from Lake Nelson, near Elizabeth Lake. Fish taken August 6, 1936; length, 16 inches.

Class of food	*No. found*	*Estimated percentage*
Water mites	14	90
Mayflies	2	5
Orl flies	1	5

All of the food found in trout from Bernice Lake (table 4) was of aquatic forms except in one instance, where the trout contained a meadow mouse. These data differ greatly from those obtained at Upper Fletcher Lake, which is just over a mountain pass and approximately four miles away, where the food covered a wide range of groups. Of greatest importance are the aquatic true flies.

In table 5 is summarized the food of four eastern brook trout taken in Helen Lake. Here again, aquatic foods were dominant. In these stomachs was found a quantity of Crustacea (Copepoda) which were the only members of this group found during the summer in the stomachs examined. They were, for the most part, well digested and impossible to count.

In table 6 are listed the foods eaten by four eastern brook trout caught in May Lake. One of the trout had nothing in the stomach, but the remainder of the alimentary canal had in it a quantity of unrecognizable material. This trout was the only one of 103 examined which had an empty stomach. The three other trout had eaten aquatic foods. Two of the three had larger pieces of rock in their stomachs than any other trout examined.

TABLE 4

Foods Consumed by Eleven Eastern Brook Trout from Bernice Lake, Elevation, 10,200 Feet. Fish taken August 10, 1936; average length, 12 inches (uniform).

Class of food	*No. found in all stomachs*	*Average percentage in all stomachs by estimated volume*
True flies (midges)	282	75
Water mites	126	10
Orl flies	4	7
Caddis flies (larvae)	2	Less than 1
Miscellaneous (mouse)	1	7
Mollusk (small clam)	4	Less than 1

TABLE 5

Foods Consumed by Four Eastern Brook Trout from Helen Lake, Elevation, 10,900 Feet. Fish taken August 14, 1936; average length, 5 inches.

Class of food	*No. found in all stomachs*	*Average percentage in all stomachs by estimated volume*
True flies (midges)	158	61
Crustacea	---	37
Caddis flies (larvae)	4	Less than 1
Wasp	1	1
Water beetle	1	1

TABLE 6

Foods Consumed by Four Eastern Brook Trout from May Lake, Elevation, 9,300 Feet.
Fish taken September 4 and 5, 1936; average length, 13 inches.

Class of food	*No. found in all stomachs*	*Average percentage in all stomachs by estimated volume*
True flies (midges)	97	65
Mollusk (small clams)	5	10
Orl flies	25	25

The following tables, 7 to 13, summarize the food contents of trout taken from several creeks and rivers at altitudes from 3,000 to 10,500 feet. A great variety of food forms are represented.

TABLE 7

Foods Consumed by Seventeen Rainbow Trout from the Merced River, Near the Lower Entrance to the Valley, at Arch Rock, Elevation 3,000 to 4,000 Feet.
Fish taken June 10 to 17, 1936; average length, 8 inches; maximum, 12 inches; minimum, 6 inches.

Class of food	*No. found in all stomachs*	*Average percentage in all stomachs by estimated volume*
Caddis flies	59	20
True flies (net-winged midges)	44	24
Mayflies	71	18
Stone flies	59	15
Beetles	45	13
True bugs	15	3
Ants, bees and wasps	9	1
Miscellaneous	14	5

TABLE 8

Food of Ten Eastern Brook Trout from Yosemite Creek, Elevation, 7,000 Feet.
Fish taken July 6, 1936; average length, 6 inches.

Class of food	*No. found in all stomachs*	*Average percentage in all stomachs by estimated volume*
Caddis flies	67	28
True flies	9	2
Mayflies	1	Less than 1
Stone flies	14	5
Beetles	87	45
True bugs	12	11
Wasps, bees and ants	39	6
Miscellaneous (1 large orl fly)	1	2.5

TABLE 9

Food of Seven Rainbow Trout from Illilouette Creek.
Elevation, 7,000 Feet.
Fish taken July 16, 1936; average length, 6 inches.

Class of food	*No. found in all stomachs*	*Average percentage in all stomachs by estimated volume*
Caddis flies	31	30
True flies	4	2
Mayflies	8	3
Stone flies	5	7
Beetles	23	40
True bugs	4	4
Wasps, bees and ants	7	3
Miscellaneous	19	10

TABLE 10

Food of Ten Rainbow Trout from Bishop Creek, Elevation, 7,000 Feet.
Fish taken July 24, 1936; average length, 7 inches.

Class of food	*No. found in all stomachs*	*Average percentage in all stomachs by estimated volume*
Caddis flies	55	10
True flies	4	6
Mayflies	7	2
Stone flies	3	2
Beetles	18	30
True bugs	8	5
Wasps, bees and ants	13	3
Miscellaneous (mostly nematodes; the remainder large uniques such as grasshoppers, orl flies and dragon-fly larvae)	75	42

TABLE 11

Food of Ten Cut-throat Trout from the Headwaters of
Dana Fork of Tuolumne River, Elevation,
10,000 to 10,500 Feet.
Fish taken July 28, 1936; average length, 7 inches.

Class of food	*No. found in all stomachs*	*Average percentage in all stomachs by estimated volume*
Caddis flies	55	18
True flies	24	4
Mayflies	4	Less than 1
Stone flies	60	69
Beetles	12	3
True bugs	--	--
Wasps, bees and ants	82	6
Miscellaneous (leafhopper)	1	Less than 1

TABLE 12

Food of Five Loch Leven Trout from the Dana Fork of Tuolumne River, Elevation, 8,500 to 9,500 Feet. Fish taken August 15 and 20, 1936; average length, 8 inches.

Class of food	*No. found in all stomachs*	*Average percentage in all stomachs by estimated volume*
Caddis flies	8	11
True flies	--	--
Mayflies	6	22
Stone flies	18	34
Beetles	--	--
True bugs	--	--
Wasps, bees and ants	28	32
Miscellaneous (leafhopper)	1	Less than 1

TABLE 13

Food of One Eastern Brook, One Loch Leven and One Rainbow Trout from Dana Fork of Tuolumne River, Elevation, 8,900 Feet. Fish taken August 28, 1936; lengths: eastern brook, 6 inches; Loch Leven, 6 inches; rainbow, 8 inches. All trout caught within one-half hour in a one-hundred yard stretch of stream. Stream bottom and current flow similar in the three places where the trout were caught.

Class of food	*Brook Trout*	*Loch Leven*	*Rainbow*	*Average percentage in all stomachs*
Caddis flies				15
pupae	1			
larvae	3	2	1	
adults			1	
True flies				Less than 1
black fly larvae	1			
midge larvae			1	
Mayflies (nymphs)	2		9	11
Stoneflies				18
nymphs	1		2	
adults		2		
Ants	12	8	7	46
Miscellaneous				10
scale insect	1			
butterfly larva		1		

The different species of trout, the stomach contents of which are shown in table 13, show no marked difference in diet, at least no more than that exhibited by individuals of the same species.

A 20-inch Loch Leven trout, weighing 3 pounds and 10 ounces, was taken from the Lyell Fork of the Tuolumne River, at an elevation of 8,600 feet on September 5, 1936. This trout had two mice in the stomach, one of which was partly digested, the other recently captured. The last caught mouse had a body length of 4 inches and the tail was an additional 2 inches. The stomach was distended and the feet of the mouse last caught protruded into the oral cavity.

The writer believes altitude to be a very important factor in the food taken by the various species of trout in Yosemite National Park even though it seems indirect in its effect. This is borne out by many observations on streams, though it is not to be considered of primary importance. That the fish examined might have disgorged their stomach

contents is possible, and an error might result in this way. On the other hand, Dimick and Mote in Oregon could find no differences in the amounts or kinds of food organisms found in stomachs of fish netted or caught on a hook.

Though this paper may suffice as a matter of general interest, it is by no means conclusive, and further studies of food of fishes are urged for more complete and detailed data of use in stream and lake management problems.

BIBLIOGRAPHY

Dimick, R. E., and Mote, D. G.

1934. A preliminary survey of the food of Oregon trout. Oregon State Agric. College, Agric. Exp. Sta., Sta. Bull., no. 323.

Juday, Chancey

1907. A study of Twin Lakes, Colorado, with especial consideration of the food of trouts. U. S. Bur. Fish., Bull., vol. 26, doc. 616, pp. 147-178.

Needham, J. G., and Needham, Paul R.

1935. Guide to the study of fresh-water biology; 3rd ed.

Needham, Paul R.

1934. Notes on the food of trout. Calif. Fish and Game, vol. 20, pp. 119-127.

1935. Stream survey work in California. Pacific Sportsman, vol. 15, no. 6, pp. 4-5.

Rayner, H. J.

1935. Insects as trout food. B. S. Thesis (manuscript) Calif. Univ., Div. Entom. Parasit.

Scott, J. W.

1930. Our present knowledge of trout food in the Rocky Mountain region. Colorado-Wyoming Acad. Sci., Journ., vol. 1, no. 2, p. 25.

Snyder, John O.

1933. California trout. Calif. Fish and Game, vol. 19, pp. 81-112.

Ward, Henry B., and Whipple, George C.

1918. Fresh-water biology; 1st ed. N. Y., John Wiley & Sons; 1111 pp.

WEIGHT LOSS IN BARRACUDA DURING PREPARATION FOR MARKET[1]

By JOHN F. JANSSEN, JR.
California State Fisheries Laboratory
Division of Fish and Game

The California barracuda, *Sphyraena argentea,* is one of the most highly esteemed fishes in the southern California fresh fish trade, as well as being an important game species. Of the present laws governing the barracuda fishery in California, one forbids the sale of individuals weighing less than three pounds in the round (California Fish and Game Code, Sec. 732, 1935–1937). When fish are cleaned at sea, it is difficult to determine after landing whether a relatively small fish weighed as much as three pounds when caught. In view of the amount of barracuda landed dressed and for convenience, it has become the custom at San Pedro to allow one-half pound for cleaning loss. In other words, a fish weighing less than two and one-half pounds dressed has been considered undersized. Occasionally, fishermen bring in small fish not only eviscerated but also with the head removed, obviously attempting to evade the legal weight limit by making it impossible for round weight to be determined. It is customary among fresh fish dealers to sell barracuda with the heads on, as the fish look more attractive, but if fish are scarce headless individuals can be sold.

The purpose of this study was to determine the loss in weight when an average three-pound barracuda is dressed, in order to aid law enforcement officers in deciding the legality of fish delivered with viscera removed or with both viscera and head removed. As will be pointed out later, a size limit based on length would be far superior to the present weight limit. However, as long as existing regulations stand, this study may be of some assistance to those charged with enforcing them.

From October, 1935, through June, 1936, samples of barracuda were obtained from time to time when fresh fish were available. Some samples were undersized fish taken from fishermen, others were legal sized fish purchased at cost from fresh fish dealers. Each fish was weighed in the round and its total length measured. The fish was then eviscerated and weighed, its head removed, and the weight taken again, thus obtaining a series of three weights for each fish.

In all, 309 fish were measured, cleaned, and weighed. From these data the percentage loss due to eviscerating and the loss resulting from eviscerating and beheading were determined for each fish.

Due to a marked increase in cleaning loss during the summer or spawning season, it was necessary to divide the data into two parts, (1) spring and summer and (2) fall and winter, and treat each group separately. From an inspection of the data and a consideration

[1] Submitted for publication, March, 1937.

of Walford's discussion of the barracuda spawning season,[2] all fish caught from April 16 to August 31 were considered as belonging in the first group, whereas those caught from September 1 to April 15 were placed in the "fall and winter" group. Such division is of necessity only arbitrary, as the weights change gradually throughout

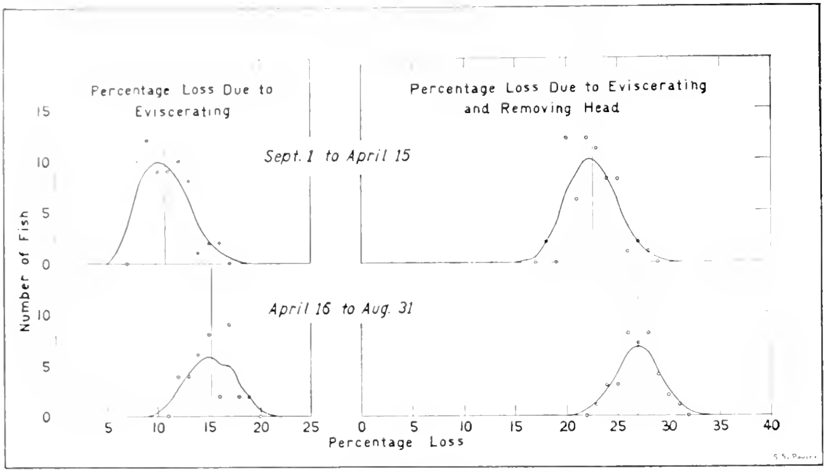

FIG. 14. Four frequency curves showing percentage loss by seasons for barracuda between 2.50 and 3.49 pounds, inclusive. The original data, indicated by the open circles, were smoothed twice by a moving average of three to show trends. Vertical lines represent the averages.

the year, but some dividing lines must be drawn to show the seasonal variations and these have proven to be the most satisfactory.

Figure 14 shows four frequency curves, two of percentage losses due to eviscerating and two of percentage losses due to eviscerating and removing the head, for all fish between 2.5 and 3.49 pounds, inclusive. The original data, indicated by the open circles, were smoothed twice by a moving average of three to show the trend. The modes and averages are considerably higher in summer than in winter, as is to be expected from the large quantity of reproductive products removed with cleaning during the summer months. Figure 15 shows the increase in cleaning loss as the fish become larger, as well as the greater loss during the spawning season in comparison to the loss during fall and winter months. As barracuda mature before they enter the commercial fishery and spawn each year of their lives thereafter, all the fish affected by size regulations are subject to seasonal changes in weight.

Table 1 shows the average percentage loss calculated by adding the individual percentage losses for all fish between 2.5 and 3.49 pounds, inclusive, and dividing the sum by the number of individuals concerned.

[2] Walford, Lionel A. The California barracuda (*Sphyraena argentea*). Calif. Div. Fish and Game, Fish Bull., no. 37, p. 16.

TABLE 1

Average percentage loss for all fish between 2.5 and 3.49 lbs., inclusive

	Percentage loss due to eviscerating	*Percentage loss due to eviscerating and removing head*
Spring and summer (April 16-August 31)	15.22	26.97
Fall and winter (September 1-April 15)	10.75	22.52

If arbitrary weights are set for eviscerated fish and for eviscerated fish with head removed, below which fish are considered to be undersized, the question arises as to whether one year around limit should be made or whether two limits be made—one for the spring and summer and the other for the fall and winter. If the allowance is set high, equal to the average loss during the spawning season, the fall and winter fish will suffer a hardship by passing as legal size when they are considerably below three pounds when caught. This would defeat the conservation principle of the present law. On the other hand, if the allowance is low, equal to the average weight loss in the fall and winter, the fishermen would be penalized during the more important summer fishing season, as many fish weighing three pounds when caught would fall below the cleaning allowance after being dressed. Therefore, setting a single limit seems inadvisable. The chief objection to enforcing two limits, one for the spring and summer and the other for fall and winter, is that as two sets of two weights each are involved,

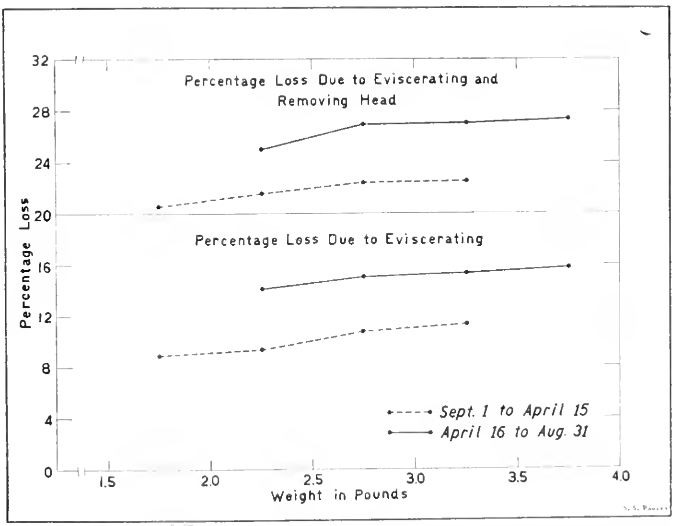

FIG. 15. Barracuda cleaning loss by size and by season. To illustrate the increase in cleaning loss as the fish become larger, the data were divided into half-pound groups.

they may be confused. However, it seems less objectionable to have two size limits on a seasonal basis rather than one all-year limit.

A definite fraction of a pound must be assigned for the average loss due to eviscerating and another for average loss due to eviscerating and beheading a three-pound fish. The averages given in table 1

are ideal, but it is obvious that odd decimal fractions and percentages can not be read off the scales used by fishermen and fish dealers. Table 2 shows the loss in pounds, by seasons, computed by converting the percentages given in table 1 to pounds in terms of loss to a three-pound round fish, and reducing the results to the nearest round numbers which may be read conveniently on the average scales.

TABLE 2

Average loss for all fish between 2.5 and 3.49 lbs., inclusive

	Loss due to eviscerating	*Loss due to eviscerating and removing head*
Spring and summer (April 16-August 31)	½ lb.	¾ lb.
Fall and winter (September 1-April 15)	⅓ lb.	½ lb.

Considering the weights given in table 2, it is recommended that all barracuda be classed as undersized which fall below the weights given in table 3.

TABLE 3

Weight of legal-size barracuda

	Round	*Eviscerated*	*Eviscerated and head removed*
Spring and summer (April 16-August 31)	3 lbs.	2½ lbs.	2¼ lbs.
Fall and winter (September 1-April 15)	3 lbs.	2⅔ lbs.	2½ lbs.

The above suggestions are made merely to aid in the enforcement of the present law. However, the law could be greatly improved by placing barracuda on a length limit. Few fishermen carry scales with them. Moreover, it is quite difficult to weigh a live barracuda accurately, especially on a rolling boat. On the other hand, these fish could be easily measured and thus many undersized individuals would be returned to the water alive. It is therefore strongly recommended that the present minimum size limit be changed from three pounds in weight to 28 inches in total length. This would mean no actual change in the minimum size limit of the fish, as a three-pound barracuda is approximately 28 inches long.

HAS THE CLOSED AREA INCREASED THE PISMO CLAM POPULATION?[1]

By FRANCES N. CLARK AND RICHARD S. CROKER
California State Fisheries Laboratory
Division of Fish and Game

To further the conservation of the Pismo clam (*Tivela stultorum*) the California Division of Fish and Game has for a number of years carried on a study of the clam population on Pismo Beach. The study consists essentially of making comparable counts from year to year of the numbers of this intensively sought mollusk. In an analysis of the 1936 census one fact stands out above all others—that is the much better survival of clams on the protected part of the beach than on the portion open to digging.

The southern or most remote part of the beach was set aside as a clam refuge (District 18A) in 1929. This was done in the hope that a breeding population could be established in this area to help repopulate the entire beach. In addition if the area proved successful it might be possible at some time in the future to open the protected area and close some other portion of the beach, alternating different parts of the beach as conditions justified.

What then is the situation in the closed area after 7 years of protection? The answer is that there are definitely more mature clams on this part of the beach than there were in 1929. The increase is due to two factors, a series of unusually good sets of young clams and the added protection given these clams. Beginning with 1929 there have been four good sets of small clams on Pismo Beach. Most of the clams resulting from the first three of these good sets, laid down in 1929, 1930 and 1931, have reached the legal size of 5 inches in greatest diameter. In the closed area these year-classes have succeeded in producing a goodly proportion of legal-sized clams and in building up a fair spawning reserve. This increase in the number of legal clams in the closed section is illustrated in figure 16, which shows the yearly percentage that the legal clams form of the total population within the intertidal zone of the closed area. From 1929 to 1933, clams of 5 inches or more comprise not more than 2 per cent of all the clams. An increase began in 1934 and by 1936 legal-sized clams made up 22 per cent of the total clam population in the area.

The increase in large clams in the closed area is of real significance when compared with conditions in the area where diggers operate. In the intertidal zone of the open beach, legal clams have been exceedingly scarce over the same period, 1929-1936. At the time of the last census, November, 1936, legal-sized clams comprised but 8/10 of 1 per cent of the clam population of this area. This paucity of large clams

[1] Submitted for publication, December, 1936.

is due to intensive digging. Not only are the clams removed as fast as they reach 5 inches, but undersized clams are taken by some diggers in spite of constant patrol on the beach.

This augmentation in the numbers of large clams in that portion of Pismo Beach set aside as a clam refuge shows quite clearly that such a program of protection, rigidly enforced, can build up, within the protected area, a much depleted clam population. As yet we have

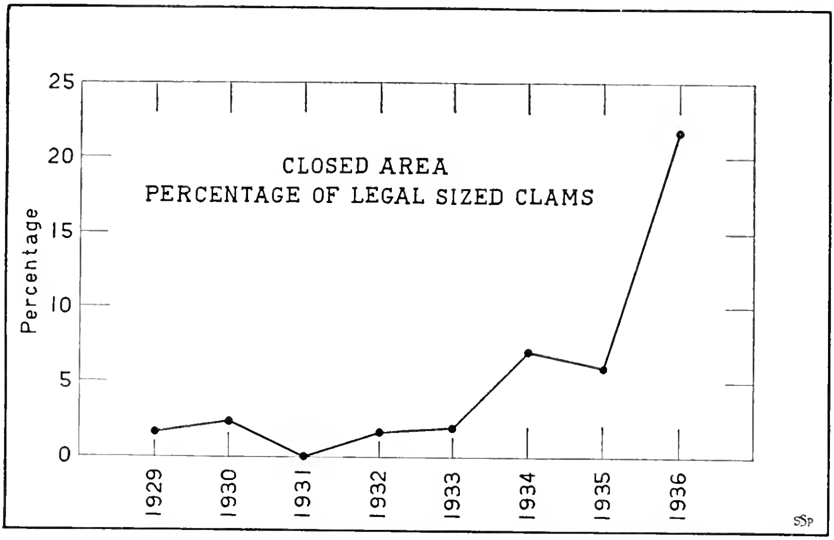

FIG. 16. Proportion of legal sized clams to all clams in the intertidal zone of the closed area of Pismo Beach (District 18A).

no positive evidence that the larger number of spawners has brought about an increase in the number of young clams produced each year along the entire beach. The data do hint, however, that the improvement in the sets during the past four years may have been somewhat influenced by this factor. The continued absence of large clams on the open beach shows, on the other hand, that a legal size and bag limit are not sufficient to do more than maintain the population of Pismo clams at its present relatively low level.

REPORT ON THE CALIFORNIA OYSTER INDUSTRY FOR 1936[1]

By PAUL BONNOT
Bureau of Commercial Fisheries
California Division of Fish and Game

California oyster growing, at present, falls into two categories. In Humboldt Bay the effort is to establish the artificial culture of the native oyster (*Ostrea lurida*), using as a base the already existing natural beds. In some of the other bays which do not contain natural growths of natives, Japanese seed oysters (*Ostrea gigas*) are imported and planted. In our research program, more time is being spent on the culture of the natives as it is imperative for a successful development of this phase of the industry, that a comprehensive biological background be established. The Japanese oyster is very hardy and so far the technical work in connection with it has consisted, for the most part, of an inspection of the incoming shipments and the designation of suitable areas which seem to possess the necessary environmental conditions conducive to rapid growth, desirable shape and sanitary excellence.

Native Oysters—Humboldt Bay

Although there are many purely biological problems to be solved in connection with the native oyster, for the time being it has seemed of more importance to devote the time exclusively to commercial aspects of oyster growing and to collect and endeavor to interpret biological data having an immediate and direct bearing on the problems of the growers. We must endeavor to create a fishery with biological knowledge based on other species and other geographical localities. As each bay seems to have its own combinations of environmental conditions, the work of other biologists can be applied only by the adoption of methods, altered when necessary, to fit local conditions, and the use of their deductions and conclusions as indicators. In this respect the work of A. E. Hopkins with the native oyster in Puget Sound has been of great assistance.

The 1936 oyster season at Humboldt Bay was an unqualified success. The artificial collectors of the commercial growers took a heavy set of native oysters and biological data were successfully obtained in satisfactory quantity. At the beginning of the season, the outlook was not very encouraging as the set of the previous season (1935) was very poor; the commercial collectors were put in at the wrong time, taking a very small set or none at all; and the scientific information collected was insufficient as a basis for making pertinent deductions. Early in May, 1936, a raid by sting rays all but eliminated

[1] Submitted for publication, March, 1937.

the natives on one of the most populous of the artificial beds. Because of these conditions only one company made up a quantity of artificial collectors.

As previously indicated the present work is an effort to create a fishery, rather than the investigation of one already established. It

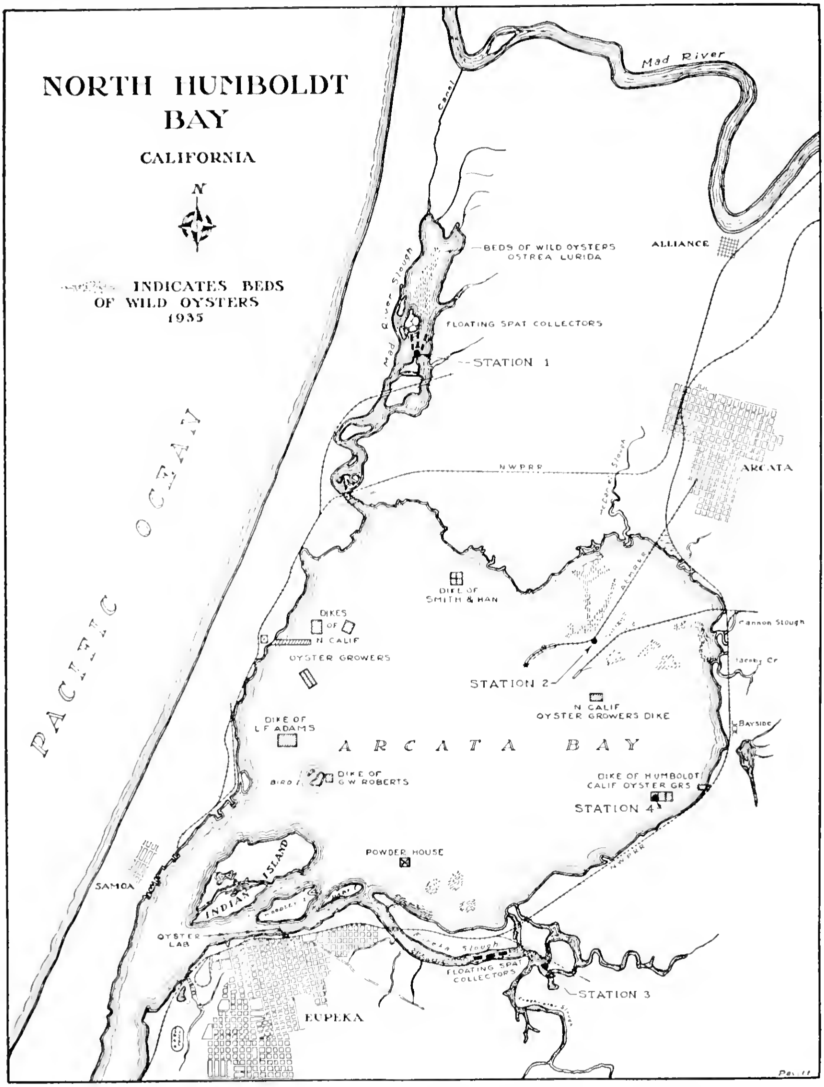

FIG. 17. Map of north Humboldt Bay, showing oyster beds.

is obvious, therefore, that the oyster industry is not at present able to support the very essential biological program. Believing in the future of the fishery, the Division of Fish and Game for several years has carried on the necessary research with the assistance of other interested agencies. The Humboldt County supervisors have con-

structed and maintained the oyster laboratory at Eureka and the various growers have willingly experimented with such suggestions as have been made to them. During the 1936 season, J. B. Johnson of the Bureau of Patrol was detailed as laboratory assistant.

The research work was conducted in the same manner as during the previous season; the same field stations and collecting units were maintained, with two minor changes.[2] The bags of shell, used to collect the setting larvae, were considered to contain 150 shells in 1935, whereas in 1936 they were rated as 100 shells. The water temperatures for 1935 were obtained in a dike at station 4, whereas in 1936 they were taken in the channel of Mad River Slough near station 1. The shell bags were put out and taken up at biweekly intervals, as before, and water samples to be tested for salinity and pH were taken at the various stations at each change of the shell bags. Oysters were collected at approximately weekly intervals, opened in the laboratory and studied to determine the degree of maturity.

In working up the shell bags, the shell was taken out from the top of the bag in lots of 25, and the spat on the inside smooth surface carefully counted. An average of three lots of 25 each was taken, added to the actual counts, and the total thus obtained multiplied by 2.36 to arrive at the total spat on 100 shells. Hopkins (unpublished manuscript) has found that the spat on the inside surface of the shell represents 35 per cent of the total number, which explains the last operation. The final total was divided by seven to obtain a daily average and the resulting figure used as a point in the set curve.

An innovation in spat collectors was introduced during the present season by the Humboldt California Oyster Growers. Thin pieces of plywood made up into sections of five slats and originally designed to cover vegetable crates were obtained from the barrel factory at Arcata. Four of the covers were tacked to a ¾-inch strip of redwood and the whole dipped in the usual mixture of sand and cement. Five or six such units were stacked, one on top of the other, and the battery thus formed placed in the dike at the proper time. The dikes hold sufficient water to keep them covered at all times. Each individual slat measures 2¼ x 22 inches. Reference to figure 18 will make clear the make-up of the units and the manner in which they are stacked together. Aside from the fact that these collectors took a very large set, several very interesting results developed in connection with their use. The most striking phenomenon was that they caught spat on both the top and bottom surfaces, with the exception of the top of the upper slat and the lower surface of the bottom slat. Oyster larvae normally swim inverted and set on the under side of a horizontal surface, and the explanation of the present departure seems to be that as the rough, cemented surfaces are only ¾ of an inch apart, the friction caused by the current makes a turbulent condition between the layers. The larvae would be rolled over and over and those that were finally deposited on an upper surface would set there. The batteries of collectors do not show an even distribution of set throughout. The outer edges took the greatest number of spat, the number becoming progressively less toward the center of the pile. This is no doubt due to the fact that the batteries were too close

[2] See 1935 report: Calif. Fish and Game, vol. 22, no. 4, pp. 284-293, 1936.

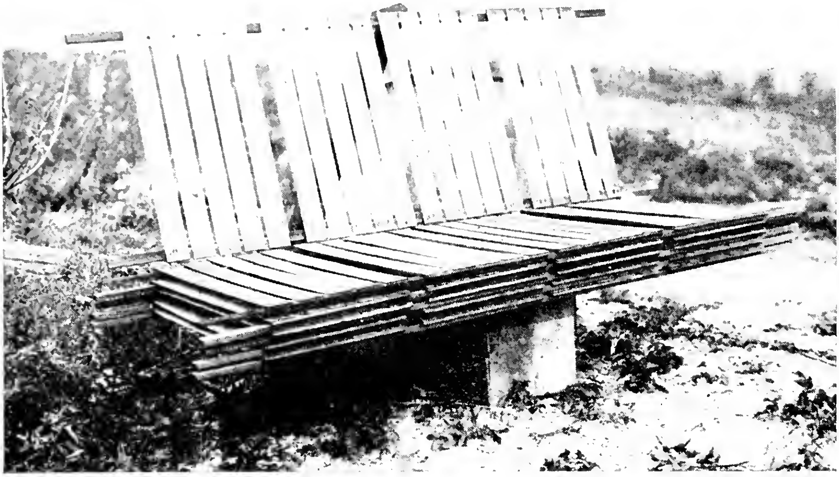

FIG. 18. Spat collector, not yet cemented, as used by Humboldt California Oyster Growers in Humboldt Bay. Photograph by Paul Bonnot, October 1, 1936.

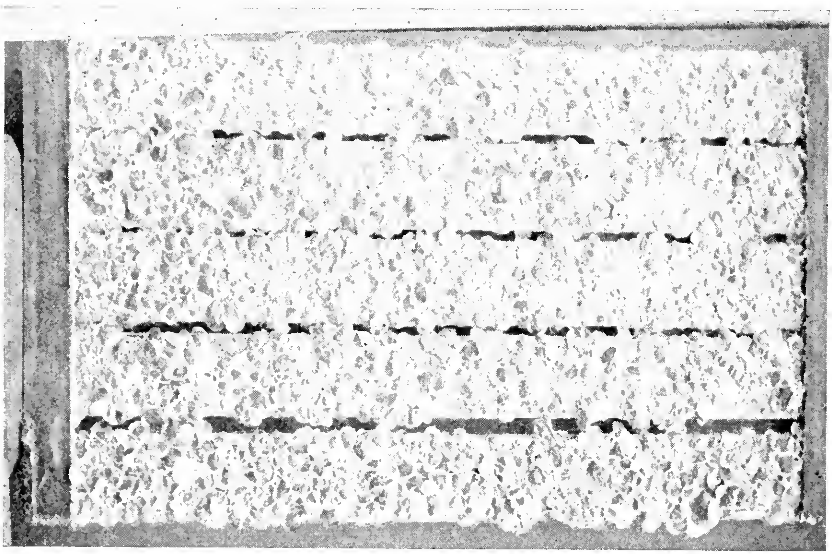

FIG. 19. A spat collector used by Humboldt California Oyster Growers in Humboldt Bay, showing a set of 50 to 60 spat per square inch. Collector put out June 1, 1936. Photograph by M. Green, August 15, 1936.

together; as one battery placed by itself, at some distance from the others, caught almost a uniform set throughout. By making up the batteries in sections of two units instead of four and spacing them farther apart in the dike, the swimming larvae would be able to reach the available surface with greater facility and the set would no doubt be more evenly distributed.

The set started early in the third week of May and by the first of June was increasing at such a rate that the Humboldt California Oyster Growers were advised to put the 4000 collectors they had made in the water. The set reached its first and greatest peak about June 15, afterwards falling and rising several times to progressively smaller highs until the middle of August. The number of spat was very large and the artificial collectors took as many as 60 to the square inch. The different high points of the set curve can be followed in a general way by a study of the size of the spat on the collectors. The spat set during the first peak were nearly ¼-inch in diameter by the time the later peaks materialized and in most cases are themselves set with from three to ten smaller spat. One company made up several thousand egg-crate collectors after the set had started and got them in the water after the largest wave of setting had passed. They took some set; more than any of the collectors in 1935 in fact, but not as many as they should have caught under the circumstances. As they were made up in a hurry the fault may be traceable to a poor cement dip.

Several independent factors or a combination of some factors may account for the heavy set of this season. Oysters seem to spawn and set in greater numbers during some seasons than in others; in some localities maintaining a definite cycle of one good setting year for two or more seasons of poor sets. The data for Humboldt Bay are, as yet, insufficient to determine what the cycle is. There was a fairly heavy set in 1934 although the intensity, distribution and time are not known. As 1936 was also a year of heavy set it may be stated tentatively that the bay will show a heavy set every other year. Several years ago, the natural beds of native oysters were extensively tonged; in some cases being almost denuded of both oysters and shell. After the damage was done the growers themselves realized the dangers of the procedure and the natural beds have not been disturbed for three years. The beds have recovered rapidly due perhaps to the 1934 set, and the oysters on them, together with those caught on the artificial collectors and planted on the prepared beds, have greatly increased the functioning brood stock.

The experimental shell bags give the best comparison of set intensity during the last two seasons. The best bag in 1935, using 150 shells as the unit, took 300 spat; whereas the best bag of 1936, with 100 shells considered the base, took 30,000. In addition to this purely mathematical comparison, it might be pointed out that the 1935 set occurred in two very small waves of only a few days each, whereas the 1936 set was continuous for a period of about three months.

One interesting point noted while counting the spat is the varying age of the young oysters. A little practice soon makes it easy to distinguish the approximate ages and as the shell bags are in the water for one week no spat older than one week will occur. During

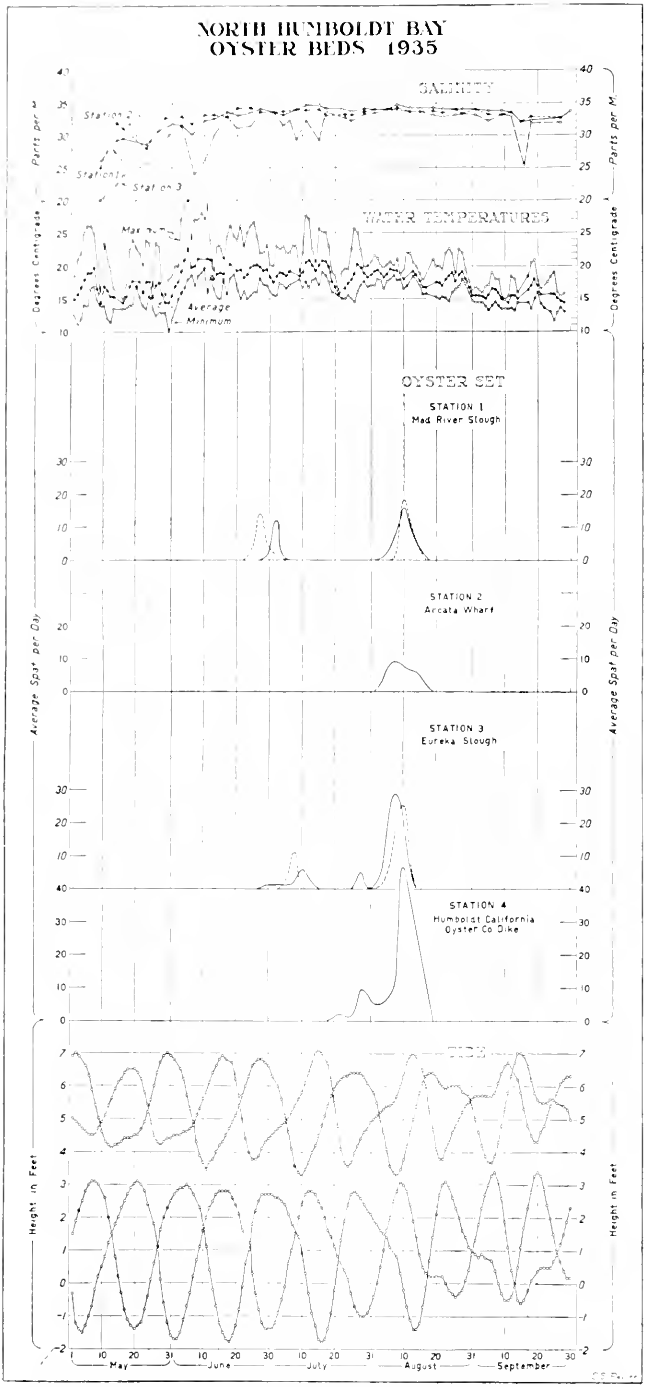

FIG. 20. Native oyster set on North Humboldt Bay, California, in 1935, demonstrating correlation with various factors.

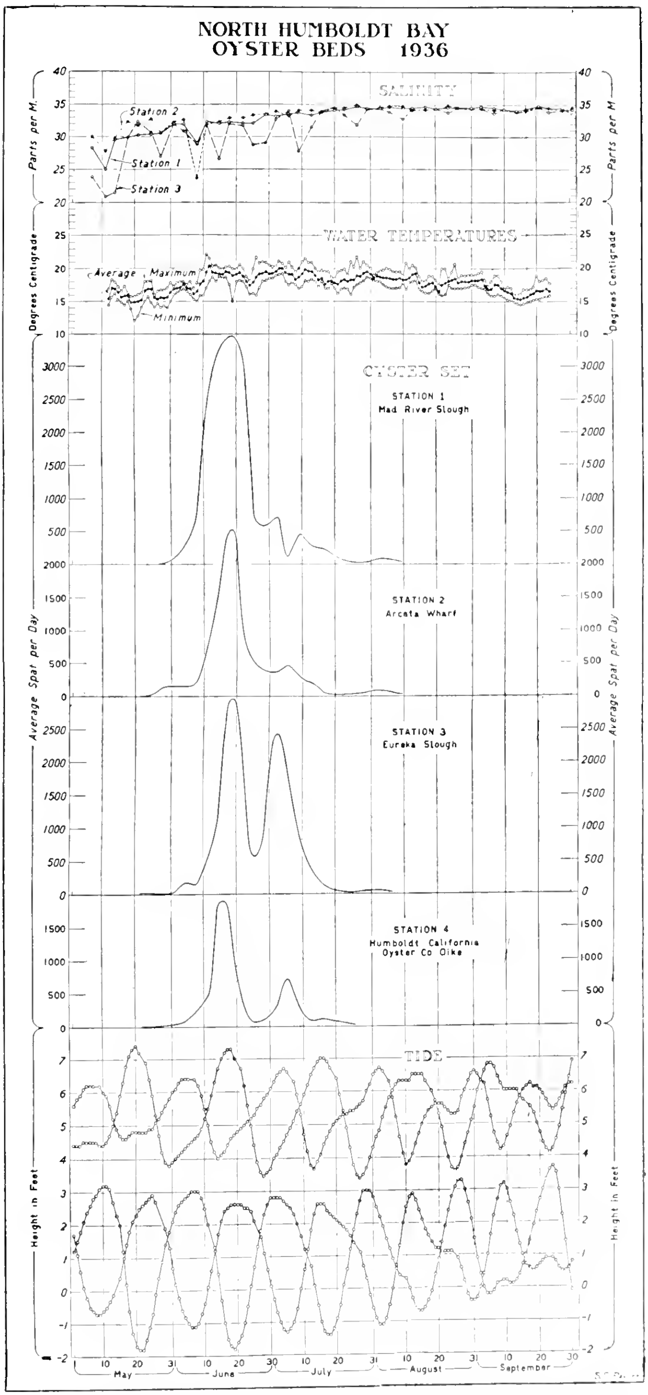

FIG. 21. Native oyster set on North Humboldt Bay, California, in 1936, demonstrating correlation with various factors.

a period of heavy setting, it would be assumed therefore that the spat would show an age graduation between those newly set and others a week old. This, however, does not happen. There are usually two or more distinct age classes. Some bags will have 80 per cent of the spat five or six days old, and 20 per cent not more than twelve hours old. The bag from the same station the following week may have these ratios reversed. It would appear therefore that although the set of any one bag is considered as a total, caught uniformly over a period of seven days, the actual set occurs in several waves within a weekly period. A closer study of this phenomenon may give some idea of the necessary combination of environmental conditions which induce the setting.

For a number of years the oyster growers have complained of losses in their stock which they attributed to crabs. There is a crab (*Cancer productus*) which can and does crack and eat oysters, but its depredations are usually of minor importance. During the early part of May, 1936, a great many native oysters were destroyed in the dikes of the Humboldt California Oyster Growers and an examination disclosed the characteristic signs of sting rays. The common bat ray (*Aetobatus californicus*) which causes considerable damage to oysters in the more southern bays was not previously known to enter Humboldt Bay. In fact, the geographical range of the species is given as Cape Mendocino south to Lower California. Although no rays could be found, a stake fence was built around part of the diked area. It required two days to put this fence in, and the upper side was left open over night with the result that two of the rays were left inside the fence by the outgoing tide during the night, proving the actual occurrence of the bat ray in the bay. Although the rays did considerable damage in these dikes, they did not molest natural or artificial beds in other parts of the bay even though none of the others were fenced. Holding a stake fence in position during the winter storms is something of a problem as eel grass and algae tend to pile up against it and the action of rough water will tear it out. However, as the rays are present in the bays only from about the first of May until the middle of August, the fences can be taken up about the first of September. The labor involved is not great and by piling the stakes up on shore and allowing them to dry, they will last much longer as the various wood-boring organisms are killed. Although redwood will outlast other woods when submerged in salt water, it has been found that many species of animals will attack it. The first dikes in Humboldt Bay were built of untreated redwood and at the end of two or three years, nearly all have been replaced as they were totally destroyed. Pressure-creosoted fir is now being used as it has been demonstrated that wood treated in this manner will last for many years.

Comparison of Data for Humboldt Bay

Some effort has been made to demonstrate correlations between the setting cycles and environmental conditions, without complete success however (see Figs. 20 and 21). Unless very definite correlations occur in a problem of this kind, two years' data are not sufficient as a basis upon which to draw definite conclusions. The set for 1935

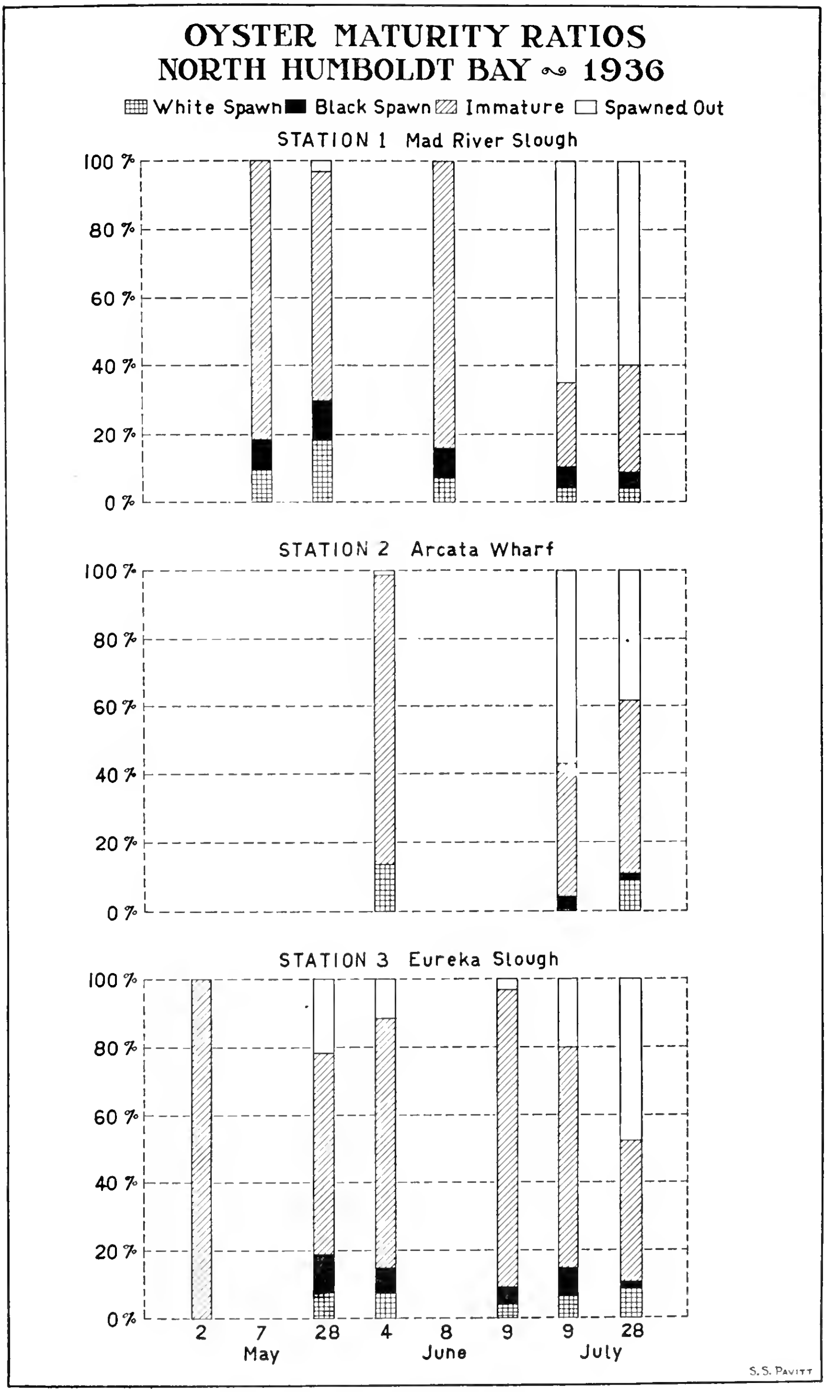

Fig. 22. Maturity ratios of native oysters on North Humboldt Bay, 1936 spawning season.

was very light, whereas that of 1936 was extremely heavy. The water temperatures in 1935 were taken at station 4, in a dike on the eastern side of the bay, whereas the 1936 temperatures were from the Mad River Slough channel near station 1. With these points in mind, a careful comparison of the curves for salinity, temperature and tides for each year and between the two years seems to show some correlation with the set curve. The following points may be significant:

Temperature

1935. The average temperature curve follows the set curve to some extent.

1936. There is a distinct correlation between the average temperature curve and the set curve, the peaks of the set curve corresponding to the peaks of the temperature curve. The temperature peaks are in the first two cases 20° C. and in the third 18° C.

Salinity

1935. Slight correlation between salinity and set.

1936. About the same degree of correlation as the temperature curve, except that in this case the low points in the two curves correspond.

Tides

1935. The set data for this year were not sufficient to show definite relationships, but there seems to be some correlation between the tide and set curves, as suggested by Hopkins; i.e., that a wave of setting which begins during a run of neap tides will reach a peak at or shortly before the succeeding run of spring tides.

1936. A very striking correlation between the set and tide is evident during this season. The set starts on a run of neap tides and reaches the first and greatest peak exactly over the succeeding run of spring tides. After making a very decided drop the set curve rises to a second peak over the next spring tide cycle. It then falls and after missing one series of spring tides rises again over the following run of spring tides. The set did not entirely stop during this whole period but the first peak of the set curve was the highest and each succeeding rise was progressively smaller.

Eastern Oysters

As it has taken more time to produce native oysters than was at first indicated, permission was granted to the growers by the Division of Fish and Game to introduce eastern oysters (*Ostrea virginica*) and eastern seed oysters. Eastern seed oysters, because of previous failures, have not been grown in California waters for a good many years, but by obtaining seed from the more northern localities on the Atlantic coast, experimentation has shown that they can be successfully grown. A carload of one-year-old stock with some spat set on them was planted on the artificial beds during November of 1935. Both the year-old oysters and the seed have shown a remarkable growth due to the fact that feeding in local waters, with a minimum temperature of 5° C., continues during the winter, whereas the zero temperatures of the east coast cause the oysters to suspend feeding and hibernate. Encouraged by the manner in which the eastern transplants have grown, another car of seed and one-year-old stock was planted in November, 1936. This second shipment consisted of seed set on empty oyster and scallop shells and of one-year-olds still set on the original cultch. These one-year-old oysters should be large enough to be broken up by next spring.

Japanese Oysters

There are several California bays that do not produce native oysters. Local environmental conditions must be unfavorable as no wild natives are found and the absence of shell deposits indicates that none have ever been there, at least in recent geological time.

Although oysters will not spawn or set in some areas, they will grow satisfactorily if introduced, and experiments have been carried on in the barren bays with Japenese seed oysters. These experiments have extended over a number of years and have shown such encouraging results that several individuals and companies are now planting Japanese seed in California waters in some quantity. The growth of this species in local waters has been remarkable. The oysters in their native environment are accustomed to high water temperatures in summer and very low ones in winter, the range being from 0° to 35° C. The coastal waters of California have a temperature range of from 5° to 22° C. Because the water temperatures do not fall to zero, the transplanted oysters continue to feed and grow during the winter months instead of hibernating. It requires about three years to produce a market size oyster in Japan, whereas seed oysters grown in California reach a salable size in eighteen months. In one California bay under exceptionally favorable conditions, the seed have reached marketable size in eight months.

The future of the Japanese oyster seems assured as a promising canned product. The species adapts itself to canning by its rapid growth. In the can, it holds its shape well, retains its flavor and remains tender. Because of the extremely rapid growth the Japanese is not as desirable for the fresh trade as some of the slower growing species. A large planting can not be disposed of while the oysters are the proper size and a large proportion may be too large to be readily marketable. A canning operation on the other hand can handle large quantities in a short time and would not be inconvenienced by a great disparity in sizes.

Plants of Japanese oyster seed have been made in Bodega Lagoon, Drakes Estero, Tomales Bay, Elkhorn Slough and Morro Bay. Some seed has also been planted in San Francisco and Tomales bays by several oyster companies already engaged in handling imported easterns and natives. The seed is set on old oyster shell and is shipped in wooden cases. The expectation, from a case, with an average set, is 10,000 marketable oysters. The total imports of seed have slowly increased during the last few years.

Imports of Japanese Oyster Seed

1933	1295 cases
1934	1031 cases
1935	4902 cases
1936	3725 cases

The figures for 1936 would have been increased by several thousand but for the maritime strike which stopped all shipments during November and December.

EDITORIALS AND NOTES

VOLUME 23 APRIL, 1937 No. 2

J. O. SNYDER RESIGNS

It is with sincere regret that the Division of Fish and Game announces the resignation of Dr. J. O. Snyder, Chief of the Bureau of Fish Conservation. Dr. Snyder retired on January 1, 1937, to his home on the campus of Stanford University, at which seat of learning he is Professor Emeritus of Zoology and retired head of the Zoology Department.

Before his appointment as bureau chief in 1932, Dr. Snyder was connected with the Division for many years in various capacities, largely advisory. His research on Pacific salmon and on the fresh-water fishes of California has earned him a place in the front rank of specialists in those fields. It was his work with these fish, and his experience in charting the destinies of his students, that suited him so well for his position as chief of all our fish hatcheries. Under his leadership, a fine spirit developed among the men of the Bureau of Fish Conservation and, working together, they built the Bureau up to its present high standing as one of the leading agencies for game fish propagation and distribution in the United States.

Not only is the Division indebted to Dr. Snyder for his work with the Bureau of Fish Conservation but it also has him to thank for the training of many of its staff, for no less than nine of our administrative and research workers were students of his at Stanford and were guided into the conservation field by him. These include his successor as bureau chief, Alan C. Taft, who is carrying on so well since Dr. Snyder turned the reins over to him.

The Fish and Game Commission and the Division of Fish and Game are proud to have had associated with them a gentlemen of Dr. Snyder's character and reputation in the cause of conservation. We all join in wishing him happiness and success in the future.—*Herbert C. Davis, Executive Officer, California Division of Fish and Game.*

JOHN P. BABCOCK

Dr. John P. Babcock, well known fisheries expert, died on October 12, 1936, in Victoria, B. C. Dr. Babcock was appointed deputy of the California Fish and Game Commission on April 13, 1891 and in October, 1892 was made chief deputy of the departments of patrol and hatcheries, serving in that capacity until he resigned October 15, 1901. During his years of service the progress made by the California Commission in fisheries research was particularly noted and to him should be given

the credit for laying the foundation that afterwards placed California in the foremost rank of enlightened states on fisheries problems.

The high respect in which he was held is best told by the following resolution adopted by the board on receipt of his resignation:

"WHEREAS after continuous and faithful service to this board of more than eleven years, Mr. John P. Babcock, Chief Deputy, has this day tendered his resignation of that office, in order to accept a position of larger scope and greater emolument under the government of British Columbia; and Whereas the work of Mr. Babcock in the California Fish Commission has ever been marked by energy, fidelity and integrity, be it

Resolved, That the resignation aforesaid be accepted with profound regret. That the departure of Mr. Babcock is a distinct loss to the fishery interests of California. That we commend him to his new employers as a gentleman thoroughly equipped for the position he has accepted, as one whose administration of his new office will ever be marked by ability, economy, and success."

In August, 1910, Mr. Babcock was again called to California as chief deputy but only served until November 29, 1911, when he again returned to his fisheries work in British Columbia. When the International Fisheries Commission (United States and Great Britain) was formed in 1924, he was appointed chairman of the halibut research program on the Pacific halibut in United States and Canadian waters, which position he held until his retirement early in 1936, and then served in the capacity of advisor to this commission.—*J. S. Hunter, California Division of Fish and Game.*

THE WORKS PROGRESS ADMINISTRATION

The Division of Fish and Game wishes to take this opportunity to gratefully acknowledge the assistance being given by the United States Works Progress Administration. This issue of CALIFORNIA FISH AND GAME contains 2 drawings, 9 graphs and 2 maps prepared by draftsman S. S. Pavitt as part of a Works Progress Administration clerical-technical project that is operating at the California State Fisheries Laboratory at Terminal Island. This project (No. 6915), which is only one of several sponsored by the Division, was started in the early days of SERA, has operated continuously and has been of very material aid in preparing biological material and statistical data in a form suitable for publication.—*W. L. Scofield, California State Fisheries Laboratory.*

STUDY OF OCEAN CURRENTS

During the spring and summer of 1937, the California State Fisheries Laboratory, in cooperation with the Scripps Institution of Oceanography, is undertaking an investigation to determine surface currents in the ocean off the coast of southern California. This program involves the analysis of water samples for the calculation of current directions and velocities, and the release of 6,000 drift bottles between Port San Luis and San Diego and out to sea for some 175 miles. This region is the one in which the major part of the spawning of the California sar-

dine, a very important commercial fish, takes place. The purpose of this experiment is to determine the drift of eggs, larvae and young fish.

The bottles will be released along four station lines which are laid out in a southwesterly direction from Port San Luis, Santa Barbara, San Pedro, and San Diego, respectively. One thousand five hundred bottles will be thrown into the sea along each station line.

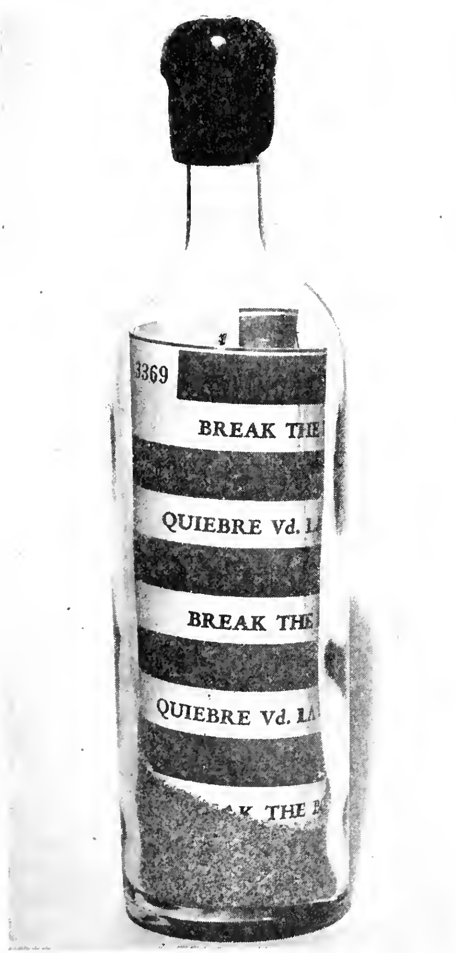

FIG. 23. Type of drift bottle used in a study of ocean currents.

The bottles are 12-ounce wine bottles, corked and with the neck dipped in marine glue. Each bottle contains three sheets of paper. The label, which is visible from the outside, is printed with conspicuous alternating red and white stripes, with instructions in English and Spanish to BREAK THE BOTTLE. Each of these labels is numbered. Inside will be found a sheet of instructions printed in both English and Spanish, telling the finder what the bottle is, its purpose, and requesting him to fill out and mail the third sheet—a postpaid business reply card. This card asks where and when the bottle was found, and the name and address of the finder. The cards are serially numbered to correspond to the number on the outer label. With these data, it will be possible to inform the finder as to where and when the bottle he found was released. The bottles are ballasted with sand until they barely stay afloat. This does away as much as possible with the effects of wind.

It is expected that many of these drift bottles will be washed ashore along the coast and should be picked up by fishermen, swimmers and others. It is requested that people be on the alert for these bottles as the Division of Fish and Game will appreciate the return of the cards which they contain.—*Richard B. Tibby, California State Fisheries Laboratory, March 17, 1937.*

OCCURRENCE OF EGRETS NEAR LONG BEACH

During the last three or four years, egrets have visited the vicinity of Long Beach in greater numbers than ten or twelve years ago. In the fall of 1925, an egret wading along the flood control channel within the Long Beach city limits was admired by the trolley car commuters as a rarity. At that time, these large white birds were occasionally seen in the marshes at the west end of the city, across the road from where the Ford Motor Company assembly plant now stands. In the fall or early winter one or two egrets might be seen, and by 1928 it was not unusual to see four or five such birds on these tidal flats.

Each fall a few more birds appeared. On November 8, 1935, a total of 16 egrets was counted across from the Ford plant. Of these, 10 were the large American egrets, *Casmerodius albus egretta,* and 6 were the smaller snowy egrets or snowy herons, *Egretta thula brewsteri.* With them were 2 blue herons. On the following day, several of these birds had left the area, as only 4 American egrets, 8 snowy herons and one blue heron were counted.

A year later, on December 16, 1936, a total of 63 egrets was counted on the same marsh. Thirty-two of these were American egrets and 31 were snowy herons. On the following day, but 24 birds were to be seen.

This interesting marsh, which has been so attractive to egrets and many kinds of shore birds, is doomed to be trampled under the advance of commercial development, for oil was discovered under the tide flats in January, 1937. Within two months, trucks were swarming to the scene with earth to make fills and a young forest of oil derricks had sprouted where egrets had pruned their white feathers but a few weeks before.—*W. L. Scofield, California State Fisheries Laboratory, March 10, 1937.*

MARKED SILVER SALMON FROM WADDELL CREEK CAUGHT NEAR FORT BRAGG

Mr. H. B. Nidever of the Bureau of Commercial Fisheries, while visiting the Paladini receiving plant at Noyo near Fort Bragg, California, on August 8, 1936, obtained a marked silver salmon (*Oncorhynchus kisutch*) which had come in that day. This fish was a male, 56 cm. in length, and had been marked by the removal of the adipose and left pectoral fins. Both silver salmon and steelhead seaward migrants were marked in this manner at Waddell Creek during the spring of 1935. Thus in order to be one of the fish from that marking the fish recovered at Noyo should show one complete and one partial year in the ocean. Examination of the scales shows this to be the case. Scale measurements for the three growth periods were as follows: 1st stream .40 mm., 1st ocean 1.22 mm., 2nd ocean 1.19 mm. This is the typical history of fish from that stream since they almost invariably spend one year in the stream and either one or two years in the ocean. This marked fish would thus have returned as an adult during the coming run in November or December. Noyo is approximately 180 miles northwest of Waddell Creek.

Mr. Alex Lambert of the Paladini Company, who first noted the marked silver salmon, reports having seen several others during the course of the season, totalling perhaps four or five.

As this is the first evidence of the movement of silver salmon in the ocean, it is hoped that during the coming year more complete records can be obtained of the marked silver salmon landed in the north coast region.—*A. C. Taft, California Division of Fish and Game, September 28, 1936.*

A RED SALMON (Oncorhynchus nerka) TAKEN IN THE KLAMATH RIVER

On August 28, 1936, Mr. Van Pelt, proprietor of the hotel at Orleans, California, while fishing near the mouth of Camp Creek, noticed a fish which was colored a much brighter red than is usual in the king salmon. Although it would not take fly or bait he was able to hook it otherwise and brought it to the hotel. Camp Creek is about 55 miles upstream from the mouth of the Klamath.

Upon examination by the writer the following morning, it was believed to be a red salmon. It was a male, $23\frac{3}{4}$ inches in length, with greatly prolonged jaws. It was quite evenly colored a bright rosy red, with a greenish tinge to the dorsal fin and the head. A count of the gill rakers on the first arch gave 14–20 on the right side and 14–21 on the left. This gives a total of 34 or 35 which falls well within the limits of the usual counts for red salmon which run from 32 to 40. The other species of Pacific salmon always have 30 or less on the first gill arch.

An examination of scales from this fish was made later and although they were badly absorbed, it was evident that this fish had spent two years in fresh water and at least two in the ocean. In addition the scales showed the reticulations along the margin between the circuli and the posterior portion of the scale, which is typical of red salmon.

Jordan and Evermann give the distribution of *Oncorhynchus nerka* as being from the Klamath northward, but there has previously been no record to substantiate this statement. Scofield (California Fish and Game, vol. 2, no. 1, Jan., 1916) reports that a cannery operator at the mouth of the Klamath stated that about 20 sockeye salmon had been taken in the nets that year. It is probable, however, that the operator was not correct in his identification as it was later found that dog salmon were occasionally reported as sockeyes or red salmon. *O. nerka* is known as red salmon in Alaska, sockeye on Puget Sound and blueback in the Columbia River.—*A. C. Taft, California Division of Fish and Game, September 28, 1936.*

REPORTS

STATEMENT OF REVENUE

For the Period July 1, 1936, to December 31, 1936, of the Eighty-eighth Fiscal Year

Revenue for Fish and Game Preservation Fund:		
Current Year:		
License Sales:		
Angling licenses, 1936	$170,245 00	
Angling licenses, 1937	147 00	
Commercial hunting club licenses, 1936-1937	750 00	
Commercial hunting club operators' licenses, 1936-1937	145 00	
Deer tags, 1936	74,870 00	
Fish breeders' licenses, 1936	30 00	
Fish importers' licenses, 1936	5 00	
Fishing party vessel permits, 1936	59 00	
Fish packers and wholesale shellfish dealers' licenses, 1936	1,005 00	
Game breeders' licenses, 1936	120 00	
Hunting licenses, 1934-1935	661 16	
Hunting licenses, 1935-1936	19,851 00	
Hunting licenses, 1936-1937	170,830 50	
Kelp licenses, 1936	10 00	
Market fishermen's licenses, 1936-1937	39,520 00	
Trapping licenses, 1936-1937	1,359 00	
Total current year		$479,607 66
Other income:		
Court fines	$40,421 68	
Fish packers' tax	149,102 60	
Fish tag sales	1,381 04	
Game tag sales	148 77	
Importers' contributions	55 00	
Interest on bank balances	3,653 48	
Kelp tax	86 04	
Lease of kelp beds	1,309 20	
Publication sales	143 39	
Salmon tax, Chap. 1015-35	12,602 20	
Miscellaneous sales	3,869 97	
Total other income		$212,773 37
Grand total		$692,381 03

STATEMENT OF EXPENDITURES

For the Period July 1, 1936, to December 31, 1936, of the Eighty-eighth Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Operating Expenditures 88th Fiscal Year:					
Administration:					
Executive	$2,499 96				$2,499 96
General office	2,760 00	$639 43	$343 25	$9 41	3,752 09
Printing, general		1,655 03			1,655 03
Automobiles		170 35	46 27		216 62
Traveling			1,207 46		1,207 46
Postage			2,330 72		2,330 72
Telephone and telegraph			1,466 93		1,466 93
Freight, cartage and express			493 05		493 05
Rent			5,010 85		5,010 85
Accident and death claims			1,919 98		1,919 98
Department administration pro rata	4,999 99		60 01		5,060 00
Librarian	900 00	105 63	31 00	71 35	1,107 98
Legal			1,682 25		1,682 25
Premiums on bonds			15 00		15 00
Publicity			1,066 60		1,066 60
Pro rata General Fund expense, Chap. 923-33			1,561 28		1,561 28
Sales tax on sales, deducted from total			—1 90		—1 90
Total Administration	$11,159 95	$2,570 44	$17,232 75	$80 76	$31,043 90
Patrol and Law Enforcement:					
Chief and assistants	$7,543 06				$7,543 06
General office	2,346 51	$44 23	$40 05	$4 04	2,434 83
Automobiles		13,394 24	5,477 29	11,192 45	30,063 98
Traveling			24,521 56		24,521 56
Postage			389 78		389 78
Telephone and telegraph			969 58		969 58
Freight, cartage and express			1 29		1 29
Rent			451 48		451 48
Captains and wardens	103,213 60	334 71	521 76		104,070 07
Launches	3,919 57	4,919 89	3,043 17	412 71	12,295 34
Premiums on bonds			15 00		15 00
Temporary help	470 81				470 81
Assistant fish and game wardens, seasonal	11,577 89				11,577 89
Heat, light, water and power			1 48		1 48
Total Patrol and Law Enforcement	$129,071 44	$18,693 07	$35,432 44	$11,609 20	$194,806 15
Commercial Fisheries:					
Chief and assistant	$5,220 00				$5,220 00
General office	4,571 61	$46 34	$13 20	$121 81	4,752 96
Automobiles		205 53	88 36	623 15	917 04
Travel			3,668 89		3,668 89
Telephone and telegraph			410 85		410 85
Freight, cartage and express			81 53		81 53
Rent			90 46		90 46
Heat, light, water and power			201 84		201 84
Research (oyster)	1,140 00	13 07			1,153 07
Laboratory	14,574 52	1,318 67	346 64	673 32	16,913 15
Fish tags		177 98			177 98
Cooperative research			500 00		500 00
Statistics		136 99	1,068 47		1,203 46
Temporary help	527 42				527 42
Terminal Island Gds.	450 00	7 83	2 43		460 26
Fish cannery auditing			545 00		545 00
Total Commercial Fisheries	$26,483 55	$1,906 41	$7,017 67	$1,418 28	$36,825 91
Fish Conservation:					
Chief and assistants	$3,630 00				$3,630 00
General office	2,558 72	$5 27	$3 40		2,567 39
Automobiles		4,867 62	1,397 68	$9 19	6,274 49
Traveling			5,700 85		5,700 85
Postage			93 94		93 94
Telephone and telegraph			519 43		519 43
Freight, cartage and express			144 79		144 79
Rent			490 49		490 49
Heat, light, water and power			875 41		875 41
Fish planting		599 69	1,672 50	14 30	2,286 49
Research			224 19		224 19
Hatcheries	54,985 15	23,783 12	325 64	542 92	79,636 83
Fish cars	900 00	1 44	925 39		1,826 83
Cooperative research	1,283 23	128 30	135 08	21 33	1,567 94
Statistical	696 78	77	534 10		1,231 65

STATEMENT OF EXPENDITURES

For the Period July 1, 1936, to December 31, 1936, of the Eighty-eighth Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Fish Conservation—Continued					
Temporary help	256 44				256 44
Special field	6,780 00	6 30	5 21		6,791 51
Fish rescue	960 00		25 50		985 50
Assistant fish and game wardens, seasonal	14,062 70				14,062 70
Total Fish Conservation	$86,113 02	$29,392 51	$13,073 60	$587 74	$129,166 87
Hydraulics:					
Chief and assistant	$3,787 96				$3,787 96
General office	960 00	$17 96	$5 86	$16 80	1,000 62
Automobiles		133 99	41 67	10 97	186 63
Traveling			1,391 62		1,391 62
Telephone and telegraph			1 20		1 20
Blue printing			20 31		20 31
Temporary help	84 64				84 64
Total Hydraulics	$4,832 60	$151 95	$1,460 66	$27 77	$6,472 98
Game Conservation:					
Chief and assistants	$6,923 31				$6,923 31
General office	2,100 00	$13 91	$19 73		2,133 64
Automobiles		1,155 22	307 05	$776 94	2,239 21
Traveling			1,870 72		1,870 72
Telephone and telegraph			218 66		218 66
Freight, cartage and express			77 81		77 81
Heat, light, water and power			1,787 73		1,787 73
Maintenance of game farms	5,664 97	8,890 75	150 71	553 47	15,259 90
Statistics	209 03	1 22	533 07		743 32
Temporary help	3,245 72				3,245 72
Maintenance of game refuge	3,158 00	123 62	84 52		3,366 14
Total Game Conservation	$21,301 03	$10,184 72	$5,050 00	$1,330 41	$37,866 16
Licenses:					
General office	$7,260 00	$3 61	$107 03	$2 16	$7,372 80
Printing licenses and applications		1,803 58			1,803 58
Traveling			239 29		239 29
Postage			826 82		826 82
Freight, cartage and express			43 39		43 39
Premiums on bonds			936 65		936 65
Identification license buttons		5,567 77			5,567 77
License commissions			33,770 26		33,770 26
Total licenses	$7,260 00	$7,374 96	$35,923 44	$2 16	$50,560 56
Special Item:					
State Fair and other exhibits (Payable from Support, Chapter 341-35 or E. O. for Support)	$40 00	$117 37	$1,200 00		$1,357 37
Total, 88th Fiscal Year:					
Expense paid from Support	$286,261 59	$70,391 43	$116,390 56	$15,056 32	$488,099 90
Prior year, 87th fiscal year, for Support					$12,017 14
Total, 87th and 88th fiscal years, for Support					$500,117 04
Special Items:					
Predatory Animal Control:					
88th fiscal year:					
Chief and assistant	$1,950 00				$1,950 00
General office	480 00			$25 00	505 00
Automobiles		$1,234 14	$241 78	13 12	1,489 04
Traveling			1,216 23		1,216 23
Predatory Animal Control	7,348 22	30 47	2,497 33		9,876 02
Predatory animal hunters and trappers	3,000 00				3,000 00
Total, 88th fiscal year	$12,778 22	$1,264 61	$3,955 34	$38 12	$18,036 29

STATEMENT OF EXPENDITURES

For the Period July 1, 1936, to December 31, 1936, of the Eighty-eighth Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Prior year, 87th fiscal year, special item—Predatory Animal Control					$68 25
Total Predatory Animal Control, 87th and 88th fiscal years					18,104 54
Total operating expenditures, 87th and 88th fiscal years					$518,221 58
Expenditures for additions and betterments:					
Permanent improvements:					
Purchase of game refuges and public shooting grounds and construction, improvements and equipment, Chap. 341-35	$11,552 33	$12,913 47	$6,829 10	$13,852 96	$45,147 86
Prior year, 87th fiscal year:					
Construction, improvements and equipment and purchase of game refuges and public shooting grounds, Chap. 341-35, all objects					$1,904 96
Total permanent improvements, 87th and 88th fiscal years					$47,052 82
Grand total					$565,274 40
Contributions to Employees' Retirement System, 88th fiscal year					$3,074 83
Total current biennium					$568,349 23
Prior biennium appropriations:					
Operating expenditures:					
Special item—Claim of Chief Accounting Officer, Department of Finance, Chap. 991-33					—71 00
Special item—Construction of Russian River Jetties, Chap. 989-33:					
88th fiscal year					117 50
Total operating expenditures					$46 50
Grand total					$568,395 73

SEIZURES OF FISH AND GAME

October, November, December, 1936

Game:		Fish:	
Deer	18	Abalone	98
Deer hides	7	Bass, black	63
Deer meat, pounds	1,085½	Bass, striped	187
Doves	128	Catfish	21
Ducks	970	Clams	1,344
Geese	41	Crabs	67
Grebe	2	Crappie	2
Grouse	4	Live car	1
Meadowlark	2	Lobsters	315
Mudhens	3	Lobsters, pounds	165
Non-game birds	11	Perch	12
Pheasant	93	Salmon	62
Pigeon	1	Salmon, pounds	200
Plover	52	Skipjack, pounds	51,284
Quail	442	Sturgeon, pounds	62
Rabbit	8	Sunfish	10
Rail	1	Trap	1
Swan	2	Trammel net	1,500ft.
Tree squirrel	1	Trout	129
Tree squirrel hides	3	Yellowfin tuna, pounds	52,123

GAME CASES

October, November, December, 1936

Offense	Number arrests	Fines imposed	Jail sentences (days)
Antelope; possession buck	3	$100 00	
Deer; killing doe, fawn, spike buck, spotted fawn; closed season; closed district; failure to retain hide and horns; failure to return tags; mutilating tags; transferring tags; failure to mark packages	123	3,906 00	1,082
Doves; closed season; overlimit	15	975 00	
Ducks; closed season; overlimit	32	2,095 00	270
Elk; possession	3		
Firearms in refuge	32	345 00	37½
Geese; overlimit	11	325 00	
Grouse; possession	3	300 00	
Hunting; no license; borrowing, transferring license; alien using citizen's license; failure to show game on demand; closed district	102	1,316 00	44½
Illegal shooting	36	552 50	
Mountain sheep; possession	1	50 00	
Night hunting	8	235 00	
Non-game birds; killing; possession; closed season	15	247 50	
Pheasant; closed season; overlimit; shipping in closed packages	60	2,070 00	55
Pigeon; closed season	1	25 00	
Poisoning birds	1	25 00	
Protected game birds; possession	6	25 00	120
Quail; closed season; overlimit; trapping	32	475 00	
Rabbits; closed season	6	156 00	2
Robins; killing	1	25 00	
Spotlighting	10	195 00	10
Swan; possession	1	25 00	
Trapping; bear; game birds	2		10
Tree squirrels; killing; possession	3	25 00	
Totals	507	$13,493 00	1,631

FISH CASES

October, November, December, 1936

Offense	Number arrests	Fines imposed	Jail sentences (days)
Abalones; overlimit; undersize	61	$1,190 00	
Bass, black; undersize	10	195 00	
Bass, striped; overlimit; undersize; selling	26	520 00	60
Clams; overlimit; undersize; out of shell; failure to show on demand; taken in preserve	50	801 50	432½
Commercial fishing; failure to keep records; no license	33	160 00	
Crabs; undersize	11	185 00	
Fishing; failure to provide passage over dam; too near dam, fishway; closed district; using prohibited gear; failure to show license on demand; transferring license; using another's license	141	2,174 00	112
Lobsters; closed season; undersize	6	115 00	
Night fishing	16	330 00	
Pollution	8	440 00	
Sardines; reducing without permit	1	100 00	
Salmon; spearing; overlimit	12	155 00	30
Skipjack; selling undersize	3	50 00	
Steelhead; overlimit	2	25 00	
Sturgeon; possession	1	20 00	
Trout; overlimit; using fresh spawn; using two poles; closed season	8	215 00	
Tuna, yellowfin; selling undersize	3	50 00	
Totals	392	$6,725 50	634½

CALIFORNIA FRESH FISH LANDINGS* FOR OCTOBER, NOVEMBER AND DECEMBER, 1936

Compiled by the Division of Fish and Game, Bureau of Commercial Fisheries

Species	Region 10, Del Norte	Region 20, Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds
Anchovy		2,020					300		2,320
Barracuda						6,786	211,412	128,878	347,076
Cabezone				300	1,107				1,407
Cabrilla							6,170	10,349	16,519
Carp			24,843						24,843
Catfish			148,679						148,679
Corbina, Mexican								1,000	1,000
Cultus, Pacific	4,823	47,148		100,931	49,190		311	1,846	204,249
Eel				4					4
Flounder, Starry	5	140		139,439	423				140,007
Flying Fish							725		725
Grouper							2,368	587	2,955
Hake				19,620					19,620
Halibut, California				2,678	2,133	78,148	36,641	118,688	238,288
Hardhead			32,249						32,249
Herring, Pacific		75		91,400				1,527	93,002
Kingfish				175	58,359	269	94,316	769	153,888
Mackerel, Horse					5,248		2,097,796		2,103,044
Mackerel, Pacific				17,324	322,962	11,058	30,178,836	2,879,704	33,409,884
Mackerel, Spanish							13,451	1,875	15,326
Mullet							3,504		3,504
Perch		185		24,974	1,614	28	12,414		39,215
Pike			25						25
Pompano, California							1,772	15	1,787
Rock Bass						1,395	36,104	35,678	73,177
Rockfish	17,518	36,944		246,516	498,083	47,932	64,561	39,379	950,933
Sablefish		29,639		783	56,476		40,577		127,475
Salmon			100						100
Sand Dab				107,589	3,454		1,597		112,640
Sardine			106,861,000	91,126,529	210,621,925	60	36,707,222	500	445,317,236
Sculpin							28,103	1,058	29,161
Sea-bass, Black						209	70,658	29,654	100,521
Sea-bass, Short-fin								5	5
Sea-bass, Totuava							251,831	41,958	293,789
Sea-bass, White				360	311	28,073	44,339	39,223	112,306
Sea-trout, California				7					7
Shark				60,546	2,049	4,014	30,525	21,836	118,970
Sheepshead						9,635	42,074	7,917	59,626
Skate				79,792	2,900	2,250	4,039	1,360	90,341

Smelt		3,773		66,441	32,056	686	83,091	1,708	187,755
Sole	952			1,500,443	8,356	79,760	577	10	1,590,098
Split-tail			3,346						3,346
Swordfish, Broadbill						341	4,084	465	4,890
Swordfish, Marlin							165		165
Tomcod				763					763
Tuna, Albacore					23,036	188	351,468		374,692
Tuna, Bluefin						3,505	260,170	24,211	287,886
Tuna, Bonito					425	3,998	219,750	520,116	744,289
Tuna, Mebachi							20,370		20,370
Tuna, Oriental							59,390		59,390
Tuna, Skipjack						7	3,504,905	6,851,615	10,356,527
Tuna, Yellowfin						30	4,075,548	15,289,954	19,365,532
Turbot				15,185	2,446				17,631
Whitefish						432	5,724	7,630	13,786
Yellowtail							173,167	1,863,656	2,036,823
Miscellaneous fish		1,341		39,325		2,123	982		43,771
Crustacean:									
Crab	80	6,516		575,340	4,584				586,520
Crab, Rock							1,628		1,628
Lobster, Spiny						107,993	190,038	246,801	544,832
Prawn					499				499
Shrimp				303,126			7,670	4,489	315,285
Mollusk:									
Abalone					150,075	455,665	210		605,950
Clam, Cockle				82			6.264		6,346
Clam, Gaper				282					282
Clam, Pismo					8,909	41,117			50,026
Clam, Soft-shell				12,051					12,051
Clam, Washington		12,799		452					13,251
Mussel					150				150
Octopus		262		365	3,498		530		4,655
Oyster, Eastern				94,220					94,220
Oyster, Japanese				114,366	270				114,636
Oyster, Native				7,064					7,064
Squid				1,468	105,682		166		107,316
Total pounds	23,378	140,842	107,070,242	94,749,940	211,966,220	885 702	78,947,543	28,174,461	521,958,328

* Importations of fresh fish from foreign countries included. See foreign importation tables.

FRESH FISH IMPORTATIONS* FROM FOREIGN COUNTRIES FOR OCTOBER, NOVEMBER AND DECEMBER, 1936

Compiled by the Division of Fish and Game, Bureau of Commercial Fisheries

Species	Landed in Region 70, Los Angeles	Landed in Region 80, San Diego	Total pounds
Barracuda	123,264	125,204	248,468
Cabrilla	6,170	10,349	16,519
Corbina, Mexican		1,000	1,000
Cultus, Pacific	275	1,803	2,078
Grouper	2,368	587	2,955
Halibut, California	9,732	88,473	98,205
Mackerel, Pacific		780	780
Mackerel, Spanish	13,451	1,875	15,326
Rock Bass	3,083	13,825	16,908
Rockfish	7,306	18,541	25,847
Sablefish	13,904		13,904
Sardine		104	104
Sea-bass, Black	69,897	27,474	97,371
Sea-bass, Totuava	251,831	41,958	293,789
Sea-bass, White	9,396	33,332	42,728
Shark	1,547	953	2,500
Sheepshead	1,218	3,736	4,954
Skate		1,360	1,360
Smelt		1,227	1,227
Swordfish, Broadbill		224	224
Tuna, Albacore	199,614		199,614
Tuna, Bluefin	1,176	5,822	6,998
Tuna, Bonito	68,643	362,534	431,177
Tuna, Mebachi	20,370		20,370
Tuna, Oriental	59,390		59,390
Tuna, Skipjack	2,164,442	6,664,587	8,829,029
Tuna, Yellowfin	4,016,733	15,254,395	19,271,128
Whitefish	1,936	3,774	5,710
Yellowtail	173,009	1,854,080	2,027,089
Miscellaneous fish	74		74
Crustacean:			
Lobster, Spiny	25,280	168,744	194,024
Shrimp	7,670	4,489	12,159
Total pounds	7,251,779	24,691,230	31,943,009

* These importations are included in tables of landings. They include fish caught by California boats in foreign waters as well as frozen fish imported for canning in California plants.

FRESH FISH IMPORTATIONS BY POINT OF ORIGIN* FOR OCTOBER, NOVEMBER AND DECEMBER, 1936

Compiled by the Division of Fish and Game, Bureau of Commercial Fisheries

Species	Gulf of California	West coast Lower California	International waters south U. S. boundary (definite origin unknown)	Mexican Mainland, Central and South America	Japan	Total pounds
Barracuda		248,468				248,468
Cabrilla	5,158	11,361				16,519
Corbina, Mexican	1,000					1,000
Cultus, Pacific		2,078				2,078
Grouper		2,955				2,955
Halibut, California		98,205				98,205
Mackerel, Pacific		780				780
Mackerel, Spanish	450	14,876				15,326
Rock Bass		16,908				16,908
Rockfish		25,847				25,847
Sablefish		13,904				13,904
Sardine		104				104
Sea-bass, Black	125	89,878	7,368			97,371
Sea-bass, Totuava	293,789					293,789
Sea-bass, White		42,728				42,728
Shark		2,500				2,500
Sheepshead		4,954				4,954
Skate		1,360				1,360
Smelt		1,227				1,227
Swordfish, Broadbill		224				224
Tuna, Albacore					199,614	199,614
Tuna, Bluefin		6,998				6,998
Tuna, Bonito		427,967	3,210			431,177
Tuna, Mebachi					20,370	20,370
Tuna, Oriental					59,390	59,390
Tuna, Skipjack		2,677,838	5,089,193	16,951	1,045,047	8,829,029
Tuna, Yellowfin		1,047,432	16,685,253	1,538,443		19,271,128
Whitefish		5,710				5,710
Yellowtail		1,832,552	194,537			2,027,089
Miscellaneous fish		74				74
Crustacean:						
Lobster, Spiny		194,024				194,024
Shrimp	7,670	4,489				12,159
Total pounds	308,192	6,775,441	21,979,561	1,555,394	1,324,421	31,943,009

* These importations are included in tables of landings. They include fish caught by California boats in foreign waters as well as frozen fish imported for canning in California plants.

O

43375 7-37 2700

BUREAU OF PATROL

E. L. MACAULAY, Chief of Patrol — San Francisco

CENTRAL DISTRICT (Headquarters, Sacramento)

S. H. Lyons, Inspector in Charge — Sacramento
L. E. Mercer, Warden, Flying Squad — Sacramento
Ed Hughes, Assistant Warden, Flying Squad — Sacramento
Chas. Sibeck, Warden, Launch "Rainbow" — Sacramento

Northern Division

Jos. H. Sanders, Captain in Charge — Sacramento
A. H. Willard, Captain — Nevada City
————, Sergeant — Redding
A. A. Jordan, Warden, Modoc County — Alturas
Brice Hammack, Warden, Siskiyou County — Yreka
Fred R. Starr, Warden, Siskiyou County — Dorris
C. L. Gourley, Warden, Trinity County — Weaverville
Chas. Love, Warden, Shasta County — Redding
C. O. Fisher, Warden, Lassen County — Susanville
W. C. Blewett, Warden, Plumas County — Quincy
R. W. Anderson, Warden, Tehama County — Red Bluff
E. C. Vail, Warden, Glenn County — Willows
E. O. Wraith, Warden, Butte County — Chico
A. Granstrom, Warden, Sierra County — Downieville
Earl Hiscox, Warden, Nevada County — Nevada City
R. A. Tinnin, Warden, Yuba County — Challenge
L. W. Dinsdale, Warden, Sutter County — Yuba City
Taylor London, Warden, Colusa County — Colusa
R. L. Sinkey, Warden, Yolo County — Woodland
W. J. Black, Warden, Solano County — Suisun
H. S. Vary, Warden, Sacramento County — Sacramento
Nelson Poole, Warden, Placer County — Auburn
Albert Sears, Warden, El Dorado County — Placerville

Southern Division

S. R. Gilloon, Captain in Charge — Fresno
John O'Connell, Captain — Stockton
———— Sergeant — Bakersfield
Wm. Hoppe, Warden, San Joaquin County — Lodi
R. J. Little, Warden, Amador County — Jackson
J. W. Thornburg, Warden, Calaveras County — Angels Camp
F. F. Johnston, Warden, Tuolumne County — Sonora
Geo. Magladry, Warden, Stanislaus County — Modesto
M. S. Clark, Warden, Merced County — Merced
Ray Ellis, Warden, Kings County — Hanford
Clarence Brown, Warden, Mariposa County — Mariposa
H. E. Black, Warden, Madera County — Madera
Paul Kehrer, Warden, Fresno County — Fresno
F. A. Bullard, Warden, Fresno County — Reedley
R. J. Bullard, Warden, Tulare County — Porterville
W. I. Long, Warden, Tulare County — Visalia
C. S. Donham, Warden, Merced County — Gustine
Lester Arnold, Warden, Kern County — Bakersfield
Roswell Welch, Warden, Kern County — Kernville

COAST DISTRICT (Headquarters, San Francisco)

K. P. Allred, Inspector in Charge — San Francisco
Scott Feland, Warden, Flying Squad — San Francisco
Eugene Durney, Assistant Warden, Flying Squad — San Francisco

Northern Division

W. J. Harp, Captain in Charge — Ukiah
J. D. Dondero, Captain — Eureka
Henry Lencioni, Captain — Santa Rosa
John Hurley, Warden, Humboldt County — Eureka
Earl Caldwell, Warden, Humboldt County — Eureka
W. F. Kaliher, Warden, Humboldt County — Fortuna
Ray Diamond, Warden, Mendocino County — Willits

CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION."

VOLUME 23 SAN FRANCISCO, JULY, 1937 Number 3

TABLE OF CONTENTS

CALIFORNIA FISH AND GAME is a publication devoted to the conservation of wildlife. It is published quarterly by the California Division of Fish and Game. All material for publication should be sent to Richard S. Croker, editor, California State Fisheries Laboratory, Terminal Island, California.

46325

FIRST REPORT OF SARDINE TAGGING IN CALIFORNIA[1]

By John F. Janssen, Jr.,
California State Fisheries Laboratory
Division of Fish and Game

Introduction

With the rapid growth of the sardine canning and reduction industry in California, continued operation of plants in British Columbia, and recent expansion of the industry into Washington and Oregon, has come an urgent need for solving the perplexing question of possible migrations of the sardine, *Sardinops caerulea* (Girard). We would like to know whether sardines occurring on the Pacific Coast of North America comprise a single population or whether various regions harbor distinct populations which mingle little or not at all with sardines in other localities. To formulate appropriate conservation measures, different methods of approach must be followed, depending upon whether the fish are migratory or not.

Evidence resulting from a long time study of the sardine, made by the California Division of Fish and Game, points to distinct migrations. Analyses of eighteen years' data on sizes, maturity, spawning grounds, anatomical characters and other factors indicate that the sardines of the Pacific Coast, from Canada to Mexico, constitute one homogeneous migratory population. These studies have led to the formulation of the following theory relating to sardine migrations: nearly all spawning takes place off southern and Lower California; the young fish remain in these southern waters until adolescence; then they commence to make northerly migrations, going at first as far as central California, and returning the following spring to southern California for spawning purposes; the older fish go farther and farther north at the close of each spawning season, so that by the time they are eight or ten years old they make annual migrations as far as British Columbia but return to southern California to spawn.

To corroborate this evidence—or disprove it—and to show the extent of migrations, the California Division of Fish and Game, in cooperation with the Biological Board of Canada and the Provincial Fisheries Department of British Columbia, inaugurated a tagging program in the spring of 1936 as an additional phase of the sardine investigation. The immediate purpose is to gain definite knowledge as to the movements of these fish throughout their range. However, as tagging technique improves—providing tagging mortality can be estimated—it may be possible to determine the proportion of the total population removed by fishing operations, as well as to approximate the size of the sardine population.

[1] Submitted for publication June, 1937.

From March 9, 1936 to May 10, 1937, the California Division of Fish and Game tagged 25,114 sardines in California waters. Although a large proportion of these fish were tagged very near the close of the fishing season and some after the close, 302 of these tags have been recovered in reduction plants in this State. As is to be expected, since

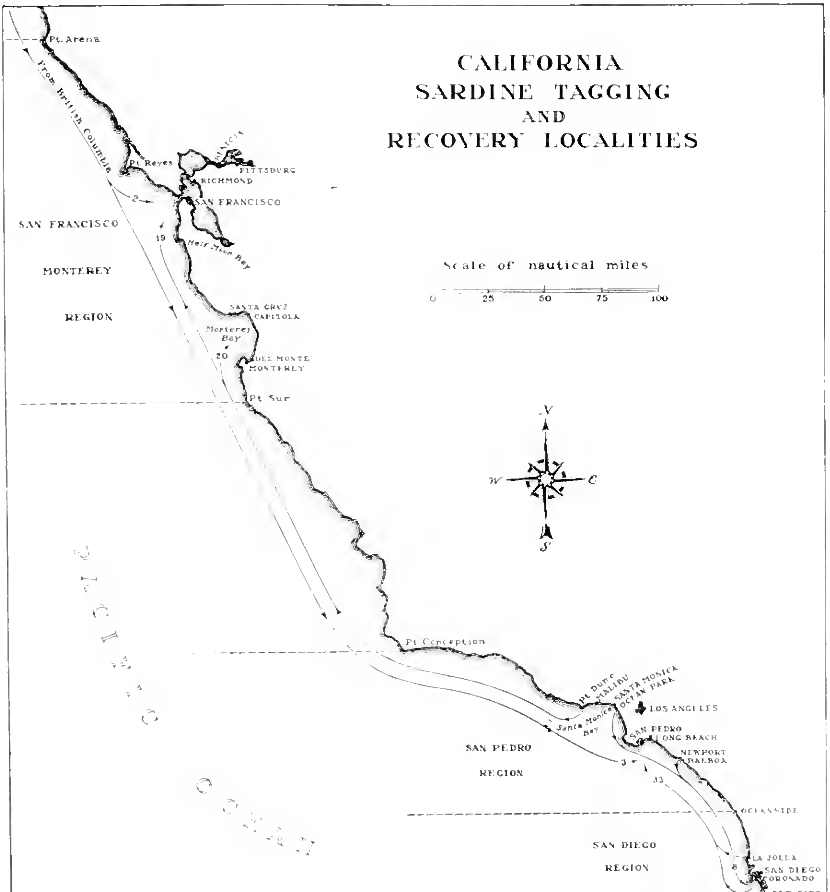

FIG. 24. A section of the California coastline showing, diagrammatically, major movements of tagged sardines from one fishing region to another, as indicated by recoveries during the 1936-1937 fishing season. Numerals represent the number of tags recovered in each locality which had been released at distant points. The number of local recoveries is not indicated. All localities in California where sardines have been tagged are shown.

tagged fish were usually released on or near the fishing grounds, most recoveries were from fish caught soon after tagging in the same fishing region as tagged. Several San Pedro tags were recovered, however, at San Francisco, Monterey and San Diego, and a few San Diego tags were recovered at San Pedro (see figure 24). In addition, 5 Canadian tags, which were placed in fish off Vancouver Island during the sum-

mer of 1936, have been recovered in California (Hart, 1937)[2]. As yet, recoveries are not numerous enough to be in themselves an indication of actual migrations of the main body of fish. However, such recoveries as have been made are in positive accord with the theory of migrations formulated from the various phases of the sardine investigation. Table 1 shows the recovery of California sardine tags by regions, as well as the number of fish tagged in each region.

TABLE 1

Summary of California Sardine Tag Recoveries, 1936-1937 Season*

A	B	C	D	E	F	G	H	I
Tagging region	Total number tagged, by regions, March, 1936 to May, 1937	Percentage of total tagged $\frac{100\,B}{\Sigma B}$	Number of recoveries by region: Recovered at San Francisco	Recovered at Monterey	Recovered at San Pedro	Recovered at San Diego	Total number recovered	Percentage recovered from each region's tagging $\frac{100\,H}{B}$
San Francisco-Monterey	8,222	32.62	4	12	----	----	16	0.19
San Pedro	14,715	58.38	19	20	201	8	248	1.69
San Diego	2,177	8.64		----	33	5	38	1.75
Lower California	91	0.36	----	----	----	----	----	----
Totals	25,205	100.00	23	32	234	13	302	1.20

* One tag recovered at the close of the 1935-1936 season at San Pedro a few days after its release in Santa Monica Bay included in table 1 and table 2.

The Tag

An internal tag has been adopted for sardine marking on the Pacific Coast. This tag closely resembles one developed and used successfully by the United States Bureau of Fisheries in its Alaska herring investigation (Rounsefell and Dahlgren, 1933). External tags or marks generally used for tracing the migrations of fish would seldom if ever be found because sardines, like herring, are caught and handled in large masses and not as individuals. In addition, tags placed within the body cavity of fish are often more permanent than those fastened externally. The sardine tag is a flat strip of nickel plated steel, $\frac{3}{4}$ of an inch long by $\frac{5}{32}$ of an inch wide by $\frac{1}{40}$ of an inch thick (see figure 25). On one side appears a serial number and on the opposite side the inscription "C.F.&G.".

The method of tag recovery by means of electro-magnets is described in another section.

Methods of Obtaining and Holding Sardines for Tagging

Southern California.

In southern California waters the fish are generally held for tagging in a live box installed on the after deck of a fast 45-foot fish and

[2] Since this report was submitted for publication, twelve additional California tags have been recovered. Belated reports of recoveries in California waters account for six of these. The remaining six were taken during July and early August, 1937, five in British Columbia and one in Oregon. The sardines bearing the six tags recovered in northern waters were released off southern California in February and March, 1937.

game patrol boat. This box is roughly 29 inches deep by 68 inches long by 28 inches wide. A small one-cylinder gasoline engine operates a pump which furnishes a constant stream of ocean water. A simple overflow arrangement at one end of the box prevents escape of fish and yet allows the water level to be regulated without decreasing the stream thrown by the pump, thus insuring ample aeration.

In California waters commercial sardine fishing is usually carried on at night during the dark of the moon, so that most of the tagging work has been done at night. The boat, with tagging crew aboard, cruises to the fishing grounds in search of a ring netter or purse seiner with sardines in her net. When one is found, and the fishermen are willing to donate a few fish to the cause, the patrol boat draws alongside the big seine skiff in order that a man with a long handled dip net can board her. By skillful maneuvering the patrol boat remains near the seine skiff, so that the man dipping fish from the seine can hand

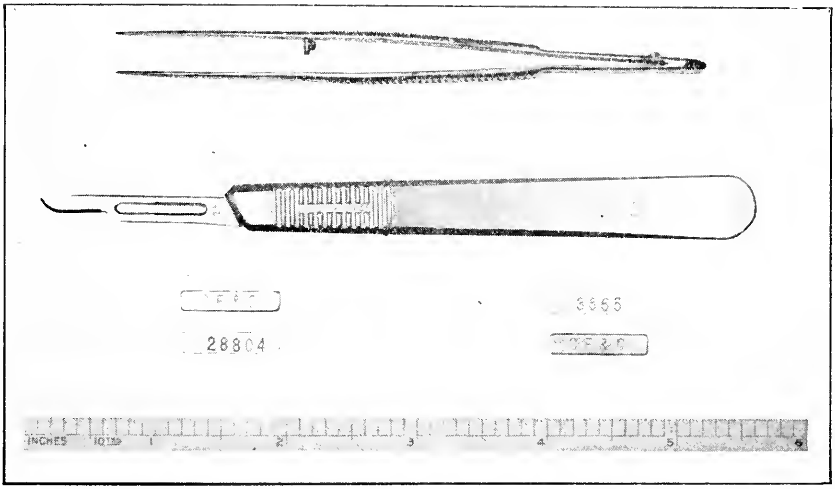

FIG. 25. California sardine tags, the scalpel for making an incision in the fish, and forceps for inserting the tag.

successive scoops of sardines to a man on the patrol boat to be put immediately into the live box.

If, as is often the case, the open sea is too rough to make tagging on the fishing grounds feasible, a hasty retreat is made to the nearest shelter, where anchor is dropped. Tagging then begins immediately under a flood light placed above the live box. By this method, 800 to 1600 sardines can be held at one time, depending upon the size of the fish. If the fish appear overcrowded, about half are transferred to an impounding net placed astern of the boat. This net is about 8 by 11 by $2\frac{1}{2}$ feet deep. Occasionally, one load has been tagged and another obtained before the boats cease fishing for the night.

Although it is the most successful method yet tried for obtaining large numbers of sardines, the use of a small boat has definite limitations. In the first place, maneuvering very near a net in rough seas is hazardous due to the danger of sinking a section of the cork line,

which might result in the loss of the fishermen's entire catch. Secondly, approaching a net too closely involves the risk of its becoming fouled in the propellers. In addition, a boat small enough to have the necessary speed and maneuverability can carry only a relatively small live box. On the other hand, a speed boat, such as has been used in this work, is able to cover a large area in a short time. If fishermen are not finding fish in one locality other districts can be scouted the same night, as not all of the fleet from any one port seeks sardines in the same area. Consequently, failures to find fish have been few. Furthermore, when the ocean is too rough to make tagging practical, only a short time is required to reach shelter, so the fish are not held very long.

Although the above method is generally used in southern California, it is necessary to rely on live bait and wholesale market boats when the active canning and reduction season is not in progress. As sportsmen commonly use small sardines for bait, a few bait fishermen have been asked to hold any catch of large sardines they might accidently make. These fish are held in small pounds or in live bait tanks essentially the same, but larger than our live box. At times, boats have been chartered with all or part of their crews. On such occasions sardines are dipped from the bag of the net and tagged on the fishing boat. After approximately 400 fish have been tagged, any remaining fish are released and a new set of the net is made. In this way tagged fish are not seriously scaled or weakened from close confinement. This method eliminates one handling of the fish and results in their being liberated in first class condition.

FIG. 26. Tagging from the live car in Monterey Bay. Photograph by Captain Lars Weseth, September, 1936.

Central California.

The patrol boat stationed in central California, the 65-foot "Albacore," is too large to risk alongside a net, so a different means of obtaining fish had to be devised. An old squid lighter, approximately 24 feet long with an 8-foot beam, was converted into a live car. A rather substantial craft is necessary as it is often towed considerable distances at sea. Its deck is roughly 3 feet about the bottom with a 4 by 13-foot hatch covered by five hatch covers. Two openings, one 17 by 27 inches and the other 14 by 23 inches, cut in the bottom and covered with heavy wire mesh, provide circulation of sea-water. Each opening has a removable cover which can be clamped watertight. The volume of the fish compartment is approximately 185 cubic feet. Four oil drums partitioned from the main fish compartment, two forward and

two aft, offer enough buoyancy to prevent the craft from sinking too deeply when full of water and fish.

The live car is towed empty to the fishing grounds by the patrol boat. When a purse seiner is found with fish in her net, three men board the lighter and row her alongside the seine skiff or the cork line of the net. Hatch covers are removed and lashed down, and the covers

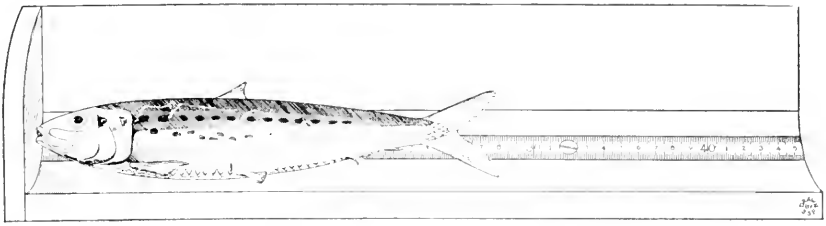

FIG. 27. Drawing of a sardine on the tagging board. The incision through which the tag is inserted is shown slightly anterior to the base of the ventral fin.

over the bottom holes removed so the craft fills with water. When approximately 500 to 1500 sardines, depending upon size, have been dipped into the fish compartment, hatch covers are fastened in place and the live car rowed a short distance from the net. The men now reboard the patrol boat which again takes the live car in tow.

Tagging is usually done at some sheltered locality. At the completion of tagging, covers are replaced over the bottom holes and the water removed from the live car to facilitate towing on the return trip to the fishing grounds.

The live car can be operated under conditions too rough to hazard a speed boat alongside a net, but its lack of speed is a decided disadvantage as the fish are kept in confinement a longer time. The speed boat can carry fish at 20 knots whereas the lighter can be towed no faster than 3 or 4—a considerable difference in speed when the fish have to be carried any distance.

Tagging Procedure

From the outset, it was evident that within practically every batch of fish obtained for tagging, there would be a large range of sizes. As differential migrations of various size-groups have been strongly suspected, it seemed worthwhile to measure each fish tagged. Such data may also give some indication as to which sizes of fish survive the marking ordeal most successfully.

To facilitate tagging and measuring, a tagging board was constructed with a millimeter rule inlaid in the concave face at a 45 degree angle, as shown in figure 27.

In order to tag the fish as rapidly as possible, two people do the actual tagging, with usually a third person dipping the fish to the taggers and recording the length of each fish on previously prepared sheets. Each sheet has a series of one hundred consecutive numbers corresponding to the numbers on the tags to be used. Fish slime collecting on smooth hands makes holding a wriggling fish difficult without

exerting undue pressure, so the taggers usually wear cotton pallbearer's gloves on their left hands.

As tags are sorted in groups of one hundred some way had to be found to handle them conveniently in the field. One method is to pour each hundred group into a dish. A tag is picked up and its number read off followed by the length of the fish to the nearest half centimeter. The recorder enters the measurement after the appropriate tag number on his sheet. A better method is to have small boards each with four rows of 25 holes numbered from 0 to 99, inclusive. These holes are about one-third as deep as a tag is long. Tags, previously inserted in the appropriate holes, are taken consecutively as used, eliminating the necessity of reading each tag number before giving the length of the fish to the recorder.

FIG. 28. Making an incision in a sardine through which a tag will be inserted, and measuring its total length. Photograph by D. H. Fry, Jr., March, 1937.

With a small dip net the recorder scoops a sardine from the fish reservoir to the taggers. One man reaches into the dip net, grasps a fish around its body at the anterior end and holds it on the concave face of the tagging board with its head against the stop at the left and its ventral surface facing the operators. While one tagger is making an incision for the tag with a sharp scalpel held in the right hand his partner presses the upper and lower lobes of the caudal fin together slightly with his left hand and reads off the sardine's total length (see figure 28). At the same time the partner picks up a tag and places it part way within the incision with his right hand, then pushes it clear into the body cavity with a pair of forceps (see figures 29 and 30) so that it lies between the viscera and body wall. The tagged sardine is immediately dropped overboard.

The position of the incision depends somewhat upon the size of the fish to be tagged. It is slightly above the insertion of the left ventral

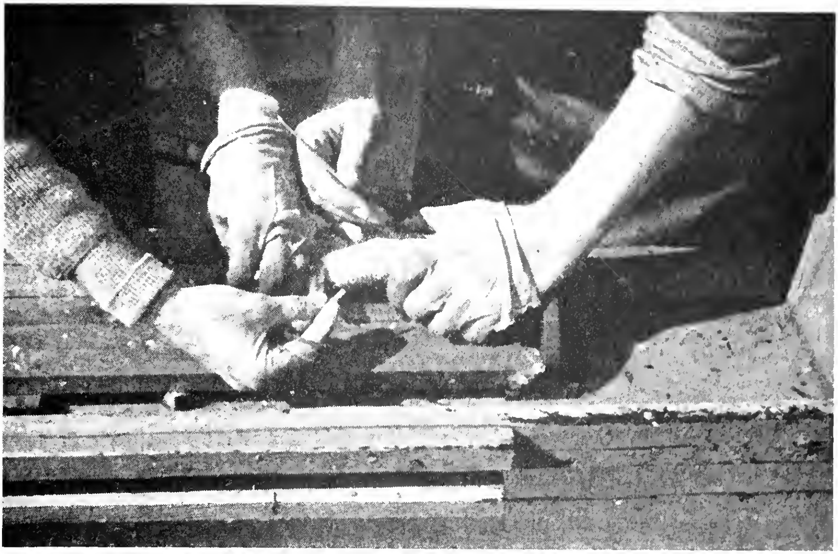

FIG. 29. The tag held in the foreground will be pushed into the incision when the scalpel is removed. Photographed by D. H. Fry, Jr., March, 1937.

FIG. 30. Pushing a tag into the body cavity of a sardine with a pair of forceps so it will lie between the viscera and body wall. Photograph by D. H. Fry, Jr., March, 1937.

fin in average sized fish, above and a little anterior to the fin in large fish, and above and behind the fin in very small fish.

Only once have tagged fish been held to be released as a school after tagging was completed. It seems advisable to release each one immediately after tagging as the fish weaken rapidly in confinement. Often tagged fish linger near the boat and school in small groups before disappearing. This is most noticeable at night when tagging takes place under a strong light. When there are fish in the impounding net, tagged individuals try and often succeed in joining their untagged companions by going over the cork line.

Several types of scalpels have been used at various times. The one proving most satisfactory is shown in figure 25. The blade is the same width as a tag and is sharp on one edge and at the end. Blades are relatively cheap and removable from the handle, so they may be replaced frequently, thus insuring a sharp edge at all times. No stop is put on the blades to regulate the depth of an incision, for after a little experience the scalpel can be controlled without danger of its cutting too deeply. Furthermore, the depth of an incision must vary in relation to the size of the fish.

No attempt has been made to use sterile instruments or tags.

Although the rate of tagging varies considerably under different conditions, a crew of three can tag approximately 300 fish an hour, whereas under very favorable conditions it is not unusual to tag 400 fish an hour.

Sizes of Sardines Tagged

Although no holding tank experiments have been performed in order to estimate the percentage of mortality due to tagging or to determine the size of the smallest fish which may safely be marked with the tags now in use, such studies are contemplated for the future. Recoveries are still not numerous enough to indicate one way or another that a fair proportion of the smaller fish survive. Sardines under 180 millimeters, total length, are usually avoided. However, a few individuals as small as 145 millimeters have been tagged.

No size discrimination has been made in the case of larger sardines. All fish above 180 millimeters, total length, have been tagged; a few were as large as 340 millimeters. The majority of the sardines tagged to date represent a fair cross-section of the commercial catch, as is to be expected since they were obtained from nets of commercial boats. A few fish taken during the off season averaged smaller than the cannery and reduction plant catch.

It may become necessary in the future to use a tag smaller than the present one for young fish which are found in southern California and Lower California waters. Marking these young fish may help to determine if they later enter the commercial fishery, and if so, when and where.

Method of Tag Recovery

Sardine tags are recovered by means of electro-magnets placed in the meal lines of reduction plants (Fry, 1937). Many whole fish, as well as offal from the canning process, are conveyed to the reduction plants. Briefly the process of reduction is as follows: The fish are

run through a press which extracts the oil. The residue is coarsely chopped and run through a drier where it crumbles into small pieces. This mass then passes over a magnet before going into a grinder. By this means, the tag only and not the fish is recovered.

In all localities in California, magnets are supplied by the California Division of Fish and Game and installed by the reduction plants, except in the case of a few plants which operate private magnets to keep metal scrap out of their grinders. The magnets pick up unbelievable quantities of metal such as nails, bolts, fish hooks and broken pieces of machinery, which somehow find their way into the reduction pit. Consequently careful sorting is necessary to find all of the tags which may have collected on a magnet. Usually scrap from magnets is sorted for tags by an employee of the Division of Fish and Game, but occasionally the reduction plant employees do this.

The number of tags recovered by this system of magnets in the meal lines is dependent not only on the number of magnets in operation but on their efficiency. Many tons of sardines are used for canning rather than reduction. During conveyance of offal from the cannery to the reduction plant a large proportion of the tags are lost. On the other hand, about 90 per cent of the tags in fish going direct to the reduction plant are picked up by the magnets. Consequently, plants running straight reduction can be expected to pick up more tags than combined canning and reduction plants for each ton of fish received.

In so far as funds have allowed, magnets have been placed in all reduction plants where their installation is mechanically possible. During the 1936-1937 sardine season magnets were installed in less than one-half of the California plants, and not all of the magnets were in operation throughout the entire season. Because of these complicating factors, it has not been possible to calculate accurately the percentage of sardine meal which passed over magnets but it probably did not exceed one-third during the 1936-1937 sardine season. The number of tags recovered is presumably considerably less, therefore, than the total number of tagged fish taken by the fishermen.

Thus, our sardine tagging program will meet with greater success as we are able to increase the efficiency of our recovery methods. At least eighteen more magnets will be installed before the 1937-1938 season, but further improvements would be desirable. Although we can trace movements of tagged fish from one region to another, our present method is not efficient enough to yield reliable data on which to calculate fishing intensity and size of the sardine population. Also, as fish from many boats are often unloaded into one reduction pit, it is impossible to determine from which boat a tag may have come. Consequently, it is not possible to tell in which locality within a fishing region the fish bearing the tag may have been caught. To meet these problems in its herring investigation the United States Bureau of Fisheries has devised an electronic detector (Dahlgren, 1936). This instrument makes possible the recovery of the fish bearing the tag at the time that a boat is being unloaded, and as a result the locality in which the fish was caught can be ascertained. The cost of installing and operating this detector prohibits its use in all our California plants but the addition of two or three as a supplement to our present magnets would furnish

additional information essential for a more thorough understanding of the sardine population.

Tagging and Recovery by Regions

For convenience in discussing tagging and recoveries, the California coastline has been divided into fishing regions (see figure 24). Because the San Francisco and Monterey fishing grounds overlap, they have been combined into one region for the purpose of this discussion. San Francisco boats fish from Pt. Arena southward to Monterey Bay whereas Monterey boats fish from Pt. Reyes to Pt. Sur. The San Pedro region is considered as covering the area from Pt. Conception to Oceanside. Although San Pedro fishermen do occasionally make catches below Oceanside, the occurrence is so rare that it can be almost disregarded. The San Diego region extends from Oceanside southward to the Coronado Islands. A few fish have been tagged in Lower California waters.

San Francisco–Monterey Region.

As shown in table 1, a total of 8,222 sardines has been tagged in the San Francisco-Monterey fishing region. However, all of these fish, except 593 tagged in Halfmoon Bay, were released in Monterey Bay. This may account for the greater recovery of these fish at Monterey than at San Francisco. Recovery of only 16 of these tags, 4 at San Francisco and 12 at Monterey, is disappointing when compared with recoveries of tagged fish in other regions (see tables 1 and 2).

We have some evidence to show, although not conclusively as yet, that a far better percentage recovery may be expected from the first four hundred fish tagged in any one group. Apparently, confinement for a longer period of time is a determining factor. During the past season, due to a combination of unfavorable conditions, the northern fish were often not tagged until daylight. In the south, where far better recoveries have been obtained, the sardines have always been tagged soon after being caught. In the San Francisco-Monterey region sardines were tagged from a live car whereas in the southern regions the fish were tagged from a live box on board a speed boat. It took longer to tow the live car than to run the speed boat to shelter where tagging could be performed. This also added to the length of time the fish were held. It therefore seems advisable to improve the technique considerably in the San Francisco-Monterey region.

The canneries and reduction plants in the San Francisco Bay area are scattered along the Bay and Sacramento River from San Francisco to Pittsburg. Tags recovered in any of these reduction plants are listed as being recovered at San Francisco. Disregarding the floating reduction fleet, which operated beyond the three-mile limit, there were 18 plants operating in this region during all or part of the 1936-1937 sardine season. Seven of these plants were equipped with magnets for the recovery of tags. Practically all meal from the San Francisco floating reduction fleet is ground in one plant at San Francisco. This plant is equipped with its own magnet which has accounted for most of the 23 California tags and the 2 British Columbia tags recovered in this locality.

Of the 17 canneries and reduction plants situated on Monterey Bay, all but one are located near the town of Monterey. Magnets serving seven plants in this locality have accounted for 32 tags.

San Pedro Region.

In the San Pedro region, 14,715 sardines have been tagged. Although a great many were released toward the end of the season, and a few after the close, from which no recoveries can be expected as yet, there have been 246 returns. San Pedro tags have been recovered in all localities in California where magnets are installed (see tables 1 and 2). From 964 fish tagged in Santa Monica Bay during March and April, 1936, there have been 53 recoveries, as follows: 19 at San Francisco, 20 at Monterey and 14 at San Pedro (see table 2).

TABLE 2

California Sardine Tag Recoveries, 1936-1937 Season

Sardines tagged by locality				Number of recoveries by region					
A	B	C	D	E	F	G	H	I	J
Date tagged	Locality tagged	Number of sardines tagged	Percentage of total tagged $\frac{100\ C}{\Sigma C}$	Recovered at San Francisco	Recovered at Monterey	Recovered at San Pedro	Recovered at San Diego	Total number recovered from each day's tagging	Percentage recovered from each day's tagging $\frac{100\ I}{C}$
3/ 9/36	Santa Monica Bay	881	3.49	18	19	13	-----	50	5.68
4/29/36	Santa Monica Bay	83	0.33	1	1	1	-----	3	3.61
9/16/36	Monterey Bay	1,496	5.94	3	7	-----	-----	10	0.67
9/23/36	Monterey Bay	80	0.32	-----	-----	-----	-----	-----	-----
9/24/36	Monterey Bay	796	3.16	-----	-----	-----	-----	-----	-----
9/25/36	Monterey Bay	749	2.97	1	2	-----	-----	3	0.40
10/14/36	Monterey Bay	897	3.56	-----	3	-----	-----	3	0.33
10/15/36	Monterey Bay	1,337	5.30	-----	-----	-----	-----	-----	-----
11/19/36	Santa Monica Bay	990	3.93	-----	-----	21	1	22	2.22
11/20/36	Santa Monica Bay	683	2.71	-----	-----	9	-----	9	1.32
12/17/36	Half Moon Bay	593	2.35	-----	-----	-----	-----	-----	-----
1/14/37	Monterey Bay	197	0.78	-----	-----	-----	-----	-----	-----
1/15/37	Monterey Bay	988	3.92	-----	-----	-----	-----	-----	-----
1/16/37	Monterey Bay	1,089	4.32	-----	-----	-----	-----	-----	-----
1/23/37	Los Angeles Harbor	501	1.99	-----	-----	1	-----	1	0.20
2/ 1/37	Newport	489	1.94	-----	-----	9	-----	9	1.84
2/ 2/37	Newport	479	1.90	-----	-----	3	-----	3	0.63
2/ 3/37	Newport	1,148	4.55	-----	-----	23	5	28	2.44
2/ 4/37	Newport	1,104	4.38	-----	-----	9	1	10	0.91
2/19/37	Newport	195	0.77	-----	-----	9	-----	9	4.62
2/20/37	Newport	475	1.89	-----	-----	8	-----	8	1.68
2/23/37	Newport	423	1.68	-----	-----	6	-----	6	1.42
3/ 2/37	Newport	795	3.16	-----	-----	19	1	20	2.52
3/ 3/37	From La Jolla to Oceanside	574	2.28	-----	-----	17	4	21	3.66
3/ 9/37	Coronado	830	3.29	-----	-----	15	1	16	1.93
3/10/37	San Diego Bay	773	3.07	-----	-----	1	-----	1	0.13
3/17/37	Newport	396	1.57	-----	-----	-----	-----	-----	-----
3/19/37	Newport	630	2.50	-----	-----	6	-----	6	0.95
3/23/37	Newport	1,582	6.28	-----	-----	19	-----	19	1.20
3/24/37	Newport	1,597	6.33	-----	-----	17	-----	17	1.06
3/26/37	Newport	797	3.16	-----	-----	22	-----	22	2.76
3/27/37	Newport	680	2.70	-----	-----	3	-----	3	0.44
4/20/37	San Quentin Bay, Lower California	91	0.36	-----	-----	-----	-----	-----	-----
5/ 9/37	Long Beach	787	3.12	-----	-----	-----	-----	-----	-----
	Totals	25,205	100.00	23	32	*231	13	*299	-----

* Three broken tags recovered at San Pedro are not included in these totals.

On one occasion it was necessary to bring a live box full of fish to Balboa where tagging was performed 1½ miles within Newport Harbor. Recovery of several of these tags two days later indicated that the fish had little or no difficulty finding their way down the narrow channel to the open sea, as there is no sardine fishing within the harbor entrance. Further tagging at the same place with subsequent recoveries within a short period has confirmed this conclusion.

Tags found in canneries and reduction plants in the Los Angeles Harbor area are referred to as San Pedro recoveries even though they may be from plants located in Wilmington or Long Beach. Nine of the 14 plants in this area are provided with magnets and have recovered 234 California tags and 3 British Columbia tags.

San Diego Region.

In the San Diego region, 2,177 sardines have been tagged, with subsequent recovery of 33 tags at San Pedro and 5 tags at San Diego. The small number of these tags recovered at San Diego—compared with tags from the same group recovered at San Pedro—is accounted for by the fact that most of these fish were tagged during the last two days that appreciable amounts of sardines were taken by fishermen operating in this region although fishing continued in the San Pedro region.

It is of interest to note that from 574 fish, most of which were tagged and released one by one while the boat cruised from La Jolla to a point two miles off Oceanside, 21 recoveries have been made (see table 2). At no other time were sardines tagged under way.

On San Diego Bay, magnets are installed in three of the four reduction plants operating in that area. These have accounted for 13 tags.

Lower California.

In April, 1937, 91 sardines were tagged in San Quentin Bay, 170 miles south of San Diego. They were obtained from the bait tanks of a small tuna clipper. As most of them were very small it is doubtful if many survived marking. Larger fish could not be found at the time.

Acknowledgments

Without the wholehearted cooperation extended to the State Fisheries Laboratory of the California Division of Fish and Game by those engaged in the fishing industry, the sardine tagging program could not have progressed successfully. We therefore wish to express our appreciation to those who have had a part, especially to the fishermen who have ever been willing to donate sardines in spite of inconveniences, and to the owners and employees of the canneries and reduction plants who have cooperated to the fullest extent. We are indebted to the Bureau of Patrol of the Division for the use of their patrol boats "Albacore" and "Yellowtail," to the captains of these vessels, Lars Weseth and Edward R. Hyde, for their valuable suggestions and untiring efforts, and to the boat crews for their willingness and assistance. It is a pleasure to acknowledge the cooperation on the part of the Canadian authorities who have exchanged tagging data with us and searched for California tags on magnets installed in British Columbia. Every member on the staff of the State Fisheries Laboratory has taken

an active part not only in the actual tagging of fish and searching for recoveries in the metal scrap collected by the magnets, but in formulating plans and methods.

TABLE 3

Summary of Sardines Tagged by the California State Fisheries Laboratory, March 9, 1936 to May 10, 1937

Tag number	Number tagged[1]	Date tagged	Locality tagged and released[2]
101– 999	881	Mar. 9, 1936	Santa Monica Bay Released: Pt. Dume Cove
1000– 1099	83	Apr. 29, 1936	Santa Monica Bay Released: Between Santa Monica and Topango
1100– 2599	1,496	Sept. 16, 1936	Monterey Bay Released: Capitola Harbor
2600– 2699	80	Sept. 23, 1936	Monterey Bay Released: One mile off Capitola
2700– 3499	796	Sept. 24, 1936	Monterey Bay Released: One mile off Soquel Pt. (between Santa Cruz and Capitola)
3500– 4249	749	Sept. 25, 1936	Monterey Bay Released: Between Monterey and Del Monte
4250– 5149	897	Oct. 14, 1936	Monterey Bay Released: Santa Cruz Harbor
5150– 6499	1,337	Oct. 15, 1936	Monterey Bay Released: Santa Cruz Harbor
6500– 7499	990	Nov. 19, 1936	Santa Monica Bay Released: One mile off Ocean Park
7500– 7999	496	Nov. 20, 1936	Santa Monica Bay Released: Half mile off Malibu
8200– 8399	187	Nov. 20, 1936	Santa Monica Bay Released: Half mile off Malibu
8400– 8999	593	Dec. 17, 1936	Half Moon Bay
9000– 9199	197	Jan. 14, 1937	Monterey Bay Released: Between Monterey and Del Monte
9200–10199	988	Jan. 15, 1937	Monterey Bay Released: Between Monterey and Del Monte
10200–11299	1,089	Jan. 16, 1937	Monterey Bay Released: Between Monterey and Del Monte
12000–12499	501	Jan. 23, 1937	San Pedro Released: Half mile off Cabrillo Beach
12500–12982	489	Feb. 1, 1937	Newport Harbor Released: Quarter mile inside entrance to harbor
12983–13449	479	Feb. 2, 1937	Newport Harbor Released: Quarter mile inside entrance to harbor
13450–14599	1,148	Feb. 3, 1937	Newport Harbor Released: Quarter mile inside entrance to harbor
14600–14999	401	Feb. 4, 1937	Newport Harbor Released: Quarter mile inside entrance to harbor
18000–18699	703	Feb. 4, 1937	Newport Harbor Released: Quarter mile inside entrance to harbor
18700–18895	195	Feb. 19, 1937	Newport Harbor Released: Quarter mile inside entrance to harbor
18900–19374	475	Feb. 20, 1937	Newport Harbor Released: Quarter mile inside entrance to harbor
19375–19799	423	Feb. 23, 1937	Newport Harbor First 69 released at entrance to harbor. Last 354 released quarter mile inside entrance to harbor
19800–20599	795	Mar. 2, 1937	Newport Harbor Released: Quarter mile inside entrance to harbor
20600–21150	574	Mar. 3, 1937	First 200 released quarter mile off La Jolla; rest released while under way between La Jolla and Oceanside
21152–21999	830	Mar 9, 1937	Coronado Released: Two miles south of Coronado
22000–22775	773	Mar. 10, 1937	San Diego Bay Released: Under Ballast Pt. one-eighth mile from shore
22776–23166	396	Mar. 17, 1937	Newport Harbor Released: Balboa Pavilion
23167–23799	630	Mar. 19, 1937	Newport Harbor Released: Balboa Pavilion
23800–24568	756	Mar. 23, 1937	Newport Harbor Released: Balboa Pavilion
24569–25399	826	Mar. 23, 1937	Newport Harbor Released: One eighth mile inside entrance to harbor
25400–26999	1,597	Mar. 24, 1937	Newport Harbor Released: Balboa Pavilion
27000–27659	659	Mar. 26, 1937	Newport Harbor Released: Quarter mile inside entrance to harbor
27760–27899	138	Mar. 26, 1937	Newport Harbor Released: Quarter mile inside entrance to harbor
27900–28499	596	Mar. 27, 1937	Newport Harbor Released: Quarter mile inside entrance to harbor

TABLE 3—Continued

Summary of Sardines Tagged by the California State Fisheries Laboratory, March 9, 1936 to May 10, 1937—Continued

Tag number	Number tagged[1]	Date tagged	Locality tagged and released[2]
29850–29933	84	Mar. 27, 1937	Newport Harbor Released: Quarter mile inside entrance to harbor
28600–28692	91	Apr 20, 1937	San Quentin Bay, Lower California Released: One mile from shore at northeast side of bay
28514–28599 28693–28999	389	May 9, 1937	Long Beach Released: Half mile off Belmont Shore
29000–29399	398	May 9, 1937	Long Beach Released: Half mile off Alamitos Bay

[1] Due to imperfections in the numbering machine, there were a few scattered duplicate tags which were sometimes used. On the other hand, the machine occasionally skipped numbers and furthermore, a few tags were lost. Occasionally mackerel were found with the sardines and tagged with the internal tags. This explains any apparent discrepancy in the number of fish tagged in any series.

[2] Localities given in this table are shown in figure 24, with the exception of San Quentin Bay, Lower California.

Literature Cited

Dahlgren, Edwin H.

1936. Further developments in the tagging of the Pacific herring, *Clupea pallasii.* Cons. Perm. Int. Explor. Mer, Journ. Cons., vol. 11, no. 2, pp. 229-247, 7 figs.

Fry, Donald H., Jr.

1937. Magnetic recovery of fish tags. California Fish and Game, vol. 23, no. 1, pp. 119-124.

Hart, John Lawson.

1937. Pilchard tag returns from British Columbia and California fishing grounds. Pacific Biol. Sta., Nanaimo, and Pacific Fish. Exp. Sta., Prince Rupert, Prog. repts., no. 31, pp. 7-10, 2 figs.

1937. Tagging British Columbia pilchards (*Sardinops caerulea* (Girard)): Methods and preliminary results. British Columbia Comm. Fish., Rept. for 1936.

Rounsefell, George A., and Dahlgren, Edwin H.

1933. Tagging experiments on the Pacific herring. Cons. Perm. Int. Explor. Mer, Journ. Cons., vol. 8, no. 3, pp. 371-384, 6 figs.

TROUT AND SALMON MARKING IN CALIFORNIA [1]

By Leo Shapovalov
Bureau of Fish Conservation
California Division of Fish and Game

Each year millions of young trout and salmon are reared in the 25 hatcheries maintained by the California Division of Fish and Game and are planted in public waters throughout the State. Later many of these fish are caught in the streams and lakes and some of the salmon are taken at sea. But what percentage of the planted fish survive to be caught by fishermen? What percentage of the fish caught are hatchery-reared and what percentage the result of natural propagation? Where do the planted fish go? At what size, in what number, and in which streams should the different species of trout and salmon be released? Only by gaining some knowledge concerning these questions can the rational management of our streams and lakes be carried out and the sportsman and the commercial fisherman be assured of maximum return on their time and investment.

In order to help answer these questions the Bureau of Fish Conservation of the California Division of Fish and Game each year marks a large number of trout and salmon at several hatcheries and liberates them in various bodies of water. King (chinook, quinnat) and silver (coho) salmon and steelhead trout have all been marked and liberated as young fish in the Klamath River, in several smaller coastal streams in central California, and in the Truckee River. Some of these fish swim to far distant points, as in the case of several silver salmon that were marked in Waddell Creek, below San Francisco Bay, and recovered off Ft. Bragg, 250 miles away.

In all marking it is hoped that as many as possible of the marked fish will be recovered at a later date and can then be identified by their marks and examined. Two methods of marking fish are used in the State: one by attaching some sort of numbered tag, the other by clipping off certain combinations of fins. Tagging is employed when it is desirable to secure returns on *individual* fish, as in studying the egg production of fish returning during successive years to an egg-taking station. The sex, size and age of the fish being tagged are usually determined in such cases. Marking by clipping off certain combinations of fins is employed when it is desired to get returns only for a *group* of fish, such as a particular plant from a hatchery or a certain age group (year class) of naturally propagated fish. In such cases ordinarily the size and age of only the group, i.e., the average size, is known.

The securing of returns in coastal streams is greatly aided by the strongly developed tendency of both adult trout and salmon at sea to return to spawn in the stream which they left as young fish. This is known as homing. Some of the marked fish are planted in streams at

[1] Submitted for publication June, 1937.

which the Division maintains egg-taking stations, with the expectation that they will be recovered at these stations. However, many of the marked fish are caught by anglers and by commercial fishermen at sea. And it is in such cases that these men can greatly aid conservation and help to assure good fishing for themselves in future years by supplying the information outlined below.

In figure 31 the fins which are used in marking are shown in black; any two or three of these fins may be clipped off in marking a certain lot of fish. It is requested that anyone who catches or handles one of these fish record:

1. *Species*
2. *Sex*
3. *Date and place where caught*
4. *How fish is marked—what fins are lacking*
5. *Length in inches and quarter-inches*
6. *Weight in pounds and quarter-pounds*

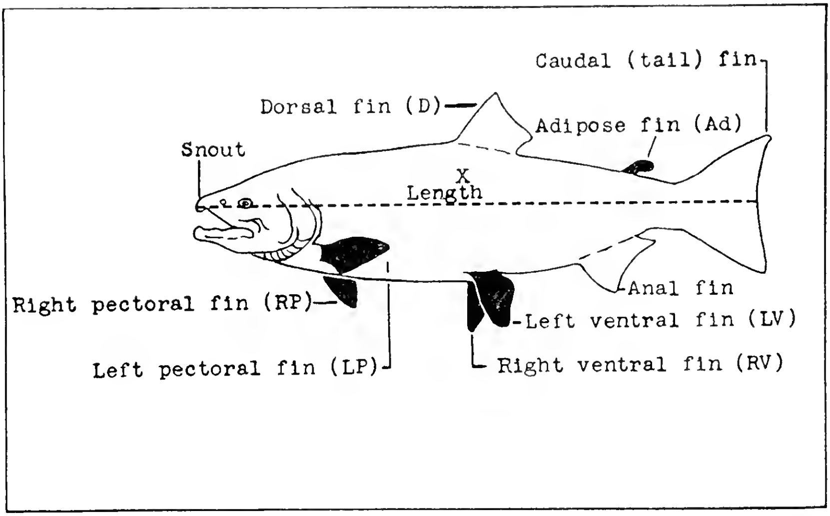

FIG. 31. Diagram showing the fins that are removed in marking trout and salmon. The abbreviations in parentheses are those used in the accompanying tables of markings.

The informant should also scrape about 30 or 40 scales from the side of the fish below the dorsal fin (from area shown by X in fig. 31) and cut out the scars where each fin was removed and place these in salt in an envelope. He should then write plainly the information asked for and his own name and address on the outside of the envelope, place it in a larger envelope, and mail to the California Division of Fish and Game, Stanford University, California, or give to any employee of the Division.

It is again emphasized that by recording their marked fish fully and accurately anglers and commercial fishermen will help the Division study the habits and migrations of the salmon and trout, and through this study to maintain the supply of these fishes.

Each person sending in a record of a marked fish will be sent a card telling where and when his fish was hatched and liberated.

The following is a record of trout and salmon marked in California during the past several years. Returns from these plants will be described at a later date.

WADDELL CREEK, SANTA CRUZ COUNTY

Year	Steelhead	Silver Salmon
1931	924 Ad-LV	1268 Ad-LV
1932	No marking	No marking
1933-34	2452 Ad-RP	3202 Ad-RP
1934-35	1013 Ad-LP	3481 Ad-LP
1935-36	3118 Both P	4392 Both P
1936-37	2745 Ad-RP	1067 Ad-RP

SCOTT CREEK, SANTA CRUZ COUNTY

Year	Species	Number	Mark	No. per oz.	Remarks
1932-33 (Jan. 11-18)	Steelhead	9,826	Ad-RV	(109 mm.)	Planted in upper lagoon
1932-33 (Jan. 19)	Steelhead	1,177	Ad only	(130 mm.)	Planted in upper lagoon
1932-33 (Feb. 3)	Silver Salmon	942	Ad-LV	(Yearlings)	
1933-34 (Jan. 11-15)	Steelhead	10,054	Both V	3.2	
1934-35 (Feb. 11-12)	Steelhead	5,608	Ad-LV	1.12	
1935-36 (Jan. 24)	Steelhead	10,030	Ad-RV	5.66	
1935-36 (Jan. 29)	Steelhead	2,249	Ad-Ant. ½D	2.18	Grisle offspring
1935-36 (June 25)	Steelhead	16,659	Both V	23.1	Marked fish offspring
1936-37 (July 9)	Silver Salmon	5,860	Both V	8.20	
1936-37 (July 9)	Silver Salmon	4,848	Both P	8.20	
1936-37 (July 14-15)	Silver Salmon	5,673	Ad-LV	7.43	

TRUCKEE RIVER, NEVADA COUNTY

Year	Species	Number	Mark	Remarks
1932	Steelhead	20,155	Ad-RV	Klamath lot
1932	Steelhead (Rainbow)	20,141	Ad-LV	Idaho lot
	Total	40,296		
1933	Steelhead	41,070	Both V	

KLAMATH RIVER, SISKIYOU COUNTY

Year	Species	Number	Mark	No. per oz.	Remarks
1934 (May 10-16)	Steelhead	23,280	Ad-RV	5.4	Beaver Cr. lot—Planted Beaver Cr.
1934 (May 10-16)	Steelhead	12,650	Ad-LV	4.5	Camp Cr. lot—Planted Fall Cr.
1934 (May 10-16)	Steelhead	9,774	Ad-Both V	8.4	Kosk Cr. lot—Planted Fall Cr.
1935 (May 9-13)	Steelhead	29,591	Both V	9.1	Planted W. Fk. Beaver Cr.
1936 (June 5, 8)	Steelhead	24,694	Ad-LV	2.59	Planted W. Fk. Beaver Cr.
1936 (June 29)	Steelhead	2,684	Ad-LV	2.1	Planted W. Fk .Beaver Cr.
1935 (Sept. 3)	King Salmon	38,170	Both V	4.	Spring run fish—Planted Fall Cr.
1936 (Aug. 15)	King Salmon	39,170	Ad-RV	5.7	Spring run fish—Planted Fall Cr.
1937 (July 31)	King Salmon	30,236	Ad-LV	3.22	Spring run fish—Planted Fall Cr.

EXPERIMENTS IN HATCHING STEELHEAD EGGS IN GRAVEL[1]

By Leo Shapovalov
Bureau of Fish Conservation
California Division of Fish and Game

Each year with the arrival of the rainy season, schools of steelhead trout fight their way up the streams of California from the Pacific Ocean and spawn in suitable gravel beds. Some weeks later their progeny emerge from the gravel, and soon millions of these fry are scattered throughout the streams in which the steelhead had spawned. What has taken place during this time? And what happens to so many of these fry, whose ranks are presently decimated to such an extent that even the casual observer can notice their strikingly fewer number?

To answer these questions correctly, we must know such things as the number of temperature units[2] required for the eggs to hatch in the gravel, the number of temperature units required for the hatched fry to work up to the surface of the gravel, the percentage of survival to time of emergence from the gravel of the eggs spawned, the weight and health of naturally hatched as compared with hatchery fish, and their comparative resistance to disease. It is essential that we secure a clear picture of what happens both in artificial and natural propagation before we can make a comparative evaluation of the two.

It was largely with the purpose of securing more light on these factors, of both theoretical and practical interest, and concerning which our information is so meager, that the writer, at the time working with the California Trout Investigation, organized the experiments outlined in the following pages. The problems are stated perhaps more fully than the extent of the present experiments would ordinarily justify for the reason that further experiments may be carried out.

The experiments were conducted at the Big Creek State Fish Hatchery, fourteen miles north of Santa Cruz, California, with eggs secured at the Scott Creek Egg-taking Station, one mile away.

Experiment No. 1

Method and Procedure.

At noon on February 6, 1936, the eggs of a steelhead trout, *Salmo gairdnerii,* 75 centimeters in length (to fork of caudal fin), were fertilized in the routine manner at the egg-taking station and then set aside in a glass two-quart jar. These eggs averaged 215 per fluid ounce. Upon becoming water-hardened, they were taken to the hatchery.

---

[1] Submitted for publication March 30, 1937.
The writer is indebted to Mr. William Berrian, foreman of the Big Creek Hatchery, who kindly kept the daily records of losses and numbers of fish hatching and emerging during the course of the experiments.

[2] One temperature unit (t. u.) equals 1° F. above 32° for a period of 24 hours.

There 1000 of the eggs were counted out and placed in a standard wire hatching basket suspended in a standard hatchery trough with flowing water. These served as a control on the experimental lot of 1000 eggs, which were buried in gravel, using the procedure outlined below. In neither lot were infertile eggs picked out before counting.

A rectangular aquarium with a cement bottom, glass sides, and window-screen in the ends was used and placed in the same trough as the control basket, and just ahead of it. This aquarium was 16 inches long, $8\frac{1}{2}$ inches wide, and 10 inches deep.

A layer of gravel which had previously been washed free of most of the sand and silt in it by being rolled around in a piece of minnow seine under water was then placed on the bottom of the aquarium. The gravel used came from the creek bed just above the dam at the Scott Creek Egg-taking Station and was selected to simulate the type and size of gravel on which the steelhead ordinarily spawn.

The bottom layer of gravel was approximately one and one-half inches deep. On this were placed 500 of the eggs, which settled into the pockets and crevices of the gravel bed. These were covered by approximately one and one-half inches of gravel, upon which the remaining 500 eggs were placed. The latter were then also covered by a layer of gravel one and one-half inches in depth. Approximately an inch of water now remained over the top of the gravel.

Black metal sheets were placed in front of and behind the aquarium in such a manner as to shut out light at the ends and yet insure a current of water running through the aquarium. The top of the aquarium was covered by a double thickness of window shade, so that it was in total darkness.

This first experiment was directed to: (1) finding out the feasibility of such experiments under existing conditions, (2) making general observations on eggs and alevins while in the gravel, and (3) comparing size and health of the fish from the gravel and in the control. Since this first experiment was more of a general observational experiment, no hesitation was exercised about taking samples and also in leaving the fry over the gravel after their emergence. In this way their behavior could be observed, but it was impossible to record the exact number hatching each day and the exact day of maximum hatch, these being reserved for the second experiment.

Beginning February 10, the fourth day of the experiment, heavy rains caused the water to become extremely and unusually muddy. This muddy water continued for nine days. The exact effect on the eggs in the gravel cannot be told, except by inference from the survival data, but it was observed that there was a heavy coating of silt on top of the gravel and down the sides of the aquarium, reaching the eggs. The effect of these conditions and its application to naturally spawned eggs will be discussed in the summary. It may be significant that in the control lot the largest number of dead eggs was removed during the three days following the period of muddy water.

It was the aim in this initial experiment, then, to simulate natural conditions as closely as possible and yet permit a reasonable degree of observation on the eggs in the gravel.

Results.

The eggs in the gravel hatched at approximately the same time as the control eggs. At the time of the first hatch in the control basket, some good and some bad eggs could be seen in the gravel. Apparently a little fungus was present but this could not be made out for certain.

The eggs in the control hatched during a period of four days, with March 7 the day of maximum hatch.

A sample of 41 fish was taken from the control trough on the second day after the eggs had hatched. These fish averaged 17.2 millimeters (0.68 inch) in total length (range 17-18 millimeters) and 0.105 gram (270 fish per ounce) in weight. They were dried on a paper towel for one minute before weighing. Both measurement and weighing were done with the fish preserved.

Feeding was begun in the control lot March 26, at the same time that it was begun in the regular hatchery fish of the same age. The first fish emerged from the gravel in the aquarium on the same day. On the following day one more fish appeared over the gravel and on March 28 two more. On March 29 there was a total of 30, and on March 31 a total of 60. Samples of 50 fish from the aquarium and 49 from the control trough were taken on this last day, and weighed and measured in the same manner as in the previous sample. The fish from the aquarium averaged 24.0 millimeters (0.95 inch) in total length (range 23-26 millimeters) and 0.156 gram (182 fish per ounce) in weight, whereas those from the control lot averaged 25.4 millimeters (one inch) in length (range 25-27 millimeters) and 0.182 gram (172 fish per ounce) in weight.

It is seen that the fish from the control were larger than those from the aquarium. The former fish were very even in size, and the yolk sac made only a slight protuberance. Many of those in the sample from the aquarium had a considerable yolk sac still present, showing a retarded degree of development, but appeared quite healthy and not at all weak. The fact that the fish in the control lot had been fed five days may account at least partially for the difference in size.

The long period over which the fish appeared from the gravel (approximately 16 days) is of interest.

It is also of interest that whereas the fish in the control lot died at the rate of about one fish a day from the time they hatched until April 15, when the experiment was concluded, there was no loss at all in the aquarium fish. So, although the aquarium fish were somewhat smaller than the control fish, their survival rate was better. (The losses in the control trough may have been due to injury in the course of routine trough cleaning.)

Table 1 shows the number of temperature units and the number of days that it took the eggs to reach various stages and also the mean temperature during the various periods. The table also shows the average weight and length of the fish in the different samples taken.

Table 2 shows the survival of the fish in the aquarium and in the control.

TABLE 1

	Date	Temperature units	Mean temperature for period	Number days for period
Eggs fertilized	Feb. 6	----	----	--
To eyeing	Feb. 17	188.8	49.2° F.	11
To maximum hatch in control	Mar. 7	563.0	50.8° F.	30
Average weight and length control fish (0.105 grams, 17.2 millimeters)	Mar. 10	625.0	50.9° F.	33
To first emergence from gravel	Mar. 26	936.1	51.1° F.	49
Maximum hatch control to first emergence from gravel	Mar. 26	373.1	51.6° F.	19
To maximum (?) emergence from gravel	Apr. 10	1206.1	50.8° F.	64
Maximum hatch control to maximum (?) emergence from gravel	Apr. 10	643.1	50.9° F.	34
Average weight and length control fish (0.182 grams, 25.4 millimeters)	Mar. 31	1025.1	51.0° F.	54
Average weight and length gravel fish (0.156 grams, 24.0 millimeters)	Mar. 31	1025.1	51.0° F.	54

TABLE 2

	Gravel	Control
Eggs at start	1000	1000
Eggs eyed	----	959 (95.9%)
Eggs hatched	----	832 (83.2%)
Fish emerging from gravel and fish present in control at same time	298 (29.8%) *	800 (80.0%) *

* This number includes fish that were used for the samples, since the loss in the aquarium from time of sample to final count was zero and the loss in the control from the time of first sample to time of second sample was only twenty-six, or 3.3%, meaning that probably only one fish of the sample of 41 would have died, and from time of second sample to the count of April 16, the loss was only nine, or 1.2%, meaning that probably only one fish of the sample of 49 would have died. Thus, the probability is that if the sample had not been taken the total number of fish that would have died would have been increased by only two, i.e., that 798 of the 800 fish listed would have survived in the control lot.

Experiment No. 2

Method and Procedure.

The procedure followed in the second experiment was essentially the same as that followed in the first. The eggs used in the second experiment were fertilized at 2 p.m. on April 23, 1936.

The only differences in procedure were that instead of the gravel being placed in the aquarium it was placed directly in the trough, and that the eggs were placed at a uniform depth in the gravel. First a layer of gravel was placed directly on the trough, covering the lower half of the trough to a depth of two inches, then 5,000 eggs were scattered over the gravel and were covered by an approximately uniform layer of four inches of gravel. A perforated plate was placed in front of the gravel to force water to run through it. The control consisted of 1,000 eggs from the same fish placed in a basket in the adjoining trough.

It is seen that in the second experiment no attempt was made at observation of the eggs and fish in the gravel. The experiment was largely directed to: (1) checking on the number of temperature units required for the hatched fish to work up to the surface of the gravel, removing the fry daily as they emerged, and thus securing the period of maximum hatch, and (2) checking on the percentage of survival to time of emergence from the gravel of the eggs spawned.

Results.

The eggs in the control hatched during a period of three days, May 17-19, with May 18 as the day of maximum hatch.

The day of initial emergence of fry from the gravel was May 31, when twenty appeared. The emerging fry were removed to a standard hatchery trough without gravel each day, so that an accurate check on the numbers emerging from the gravel could be kept. Maximum emergence occurred on the ninth day, when 675 fry appeared. The number gradually decreased from that figure. The total period of emergence covered twenty days. This long period of emergence checks well with the period of emergence in the first experiment, which was approximately sixteen days.

The fish as they emerged from the gravel in the second experiment, unlike those in the first, had the yolk sac almost entirely absorbed. This is probably due to the fact that all the eggs were buried deeper in the gravel than any of those in the first experiment.

Table 3 shows the number of temperature units and the number of days that it took the eggs to reach various stages and also mean temperatures during the various periods. Table 4 shows the survival of the fish from the gravel and those in the control.

On June 25, the sixth day after the last fish had emerged from the gravel, all of the fish hatched from the gravel weighed 52 ounces, or 75.9 fish per ounce (live weight). On the same date, all of the fish in the control weighed 62 fish per ounce (live weight). Factors to take into account in considering the difference in size between the two groups are the following: (1) there were approximately one-fifth as many fish in the control trough as in the other; (2) the fish most recently emerged from the gravel were considerably smaller than those which had emerged earlier in the long emergence period, lowering the average size. The control fish, on the other hand, were fairly uniform in size.

TABLE 3

	Date	Temperature units	Mean temperature for period	Number days for period
Eggs fertilized	Apr. 23	-----	----	--
To maximum hatch in control	May 18	585.5	55.4° F.	25
To first emergence from gravel	May 31	884.9	55.3° F.	38
Maximum hatch control to first emergence from gravel	May 31	309.4	55.8° F.	13
To maximum emergence from gravel	June 8	1074.6	55.4° F.	46
Maximum hatch control to maximum emergence from gravel	June 8	499.1	55.8° F.	21

TABLE 4

	Gravel	Control
Eggs at start	5000	1000
Eggs hatched	----	886 (88.6%)
Fish emerging from gravel and fish present in control at same time	3997 (79.9%)	817 (81.7%)

Subsequent Growth of Fish Hatched from the Gravel When Placed Over Gravel and in a Plain Trough.

On June 25, the entire 52 ounces of fish that had been hatched from the gravel in the second experiment were split into two lots of 26 ounces each. One lot was placed in a trough over gravel and the other in an adjoining plain trough.

There was subsequently a heavy loss of fish in each of these troughs, due to fungus, which may have been caused by handling the fish in weighing and transferring them to the troughs.

Both of these lots were fed quite sparingly. The plain trough was cleaned in the routine manner, while waste in the graveled trough was removed only in a very superficial manner.

On August 31, after over two months in these troughs, the fish in each trough weighed almost exactly the same. The trout in the plain trough totaled 55 ounces and averaged 17.7 per ounce, while those in the graveled trough totaled 54.5 ounces or 17.1 per ounce. The survival rates of the two lots had therefore been much the same.

There was a fair amount of decayed and old food and waste in the gravel but the fish in the trough did not seem to be adversely affected by this factor.

Summary and Conclusions

The purpose of the experiments was to determine at least partially the effectiveness of natural spawning of steelhead trout, *Salmo gairdnerii,* by simulation of natural conditions, and to discover what happens from the time the eggs are deposited in the gravel to their emergence from the gravel as fry.

1. In each of two experiments eggs from one adult sea-run fish were split into two lots, one of which was placed in gravel and the other in a standard hatching basket as a control.

2. In the first experiment the buried eggs were placed at depths of one and one-half inches and three inches, respectively, in a glass aquarium screened at the ends and shielded from light. In the second experiment the buried eggs were placed at a uniform depth of four inches, in a hatchery trough.

3. In the first experiment the eggs in the gravel hatched at approximately the same time as the control eggs. (The eggs in the gravel could not be seen in the second experiment.) Fish in the control trough averaged 17.2 millimeters in total length and 0.105 grams in weight, on the second day after hatching (625.0 t. u.).

4. The eggs required 563.0 to 585.5 t. u. to maximum hatch and 1074.6 to 1206.1 t. u. to maximum emergence from gravel (884.9 t. u. to earliest emergence from gravel). The number of temperature units to hatch compares favorably with that obtained for steelhead trout at the Big Creek Hatchery in 1932 by A. C. Taft and J. H. Wales, which was 566.7.

5. Sixteen to 20 days were required from initial to final emergence of fry from the gravel in the two experiments.

6. In the first experiment the fry from the gravel averaged 24.0 millimeters in total length and 0.156 grams in weight, 5 days after initial emergence from the gravel, while the control fish averaged 25.4 millimeters in length and 0.182 grams in weight at the same time. Thus, the trough fish were larger than those from the gravel; this is contrary to results obtained in Holland with Atlantic salmon, *Salmo salar* (B. Havinga, unpublished communication) and in British Columbia with sockeye salmon, *Oncorhynchus nerka* (Robertson, 1919). The smaller size of the aquarium fish may have been caused by premature

emergence, caused in turn by too shallow burial. Fry from eggs in the second experiment, deeper buried, had the yolk sac almost entirely absorbed. Premature emergence caused by shallow burial is cited by Babcock (1911) for Pacific salmon, *Oncorhynchus*. However, in the second experiment the gravel fish were also smaller than the control fish. Factors to take into account in connection with this were cited under "results" of the second experiment.

7. Though larger, the control fish died at the rate of approximately one a day in the first experiment, whereas there was no loss in the aquarium fish after emergence.

8. In the first experiment 83.2 per cent of the control eggs hatched and 80.0 per cent survived to the time that all the fish (29.8 per cent of eggs buried) from the gravel had finished emerging. In the second experiment 88.6 per cent of the control eggs hatched and 81.7 per cent survived to the time that all the fish (79.9 per cent) from the gravel had finished emerging. It is believed that in the above experiments natural (stream) conditions were simulated reasonably well. Granting this, it follows that in nature the percentage of deposited eggs which emerge from the gravel as fry may vary widely. It may be quite low (29.8 per cent) under adverse conditions (silting, caused by flood, as here, or mining) and on the other hand quite high (79.9 per cent) under good conditions. Some authors believe that under natural conditions poor fertilization occurs, and that but a small percentage of the eggs deposited become fish, but the present writer is inclined to believe, on the basis of field observations and the present experiments, that the percentage of eggs which are fertilized, hatch, and emerge from the gravel is rather high and that the heaviest losses occur during the fry stage.

9. Equal lots of the fish hatched from the gravel in the second experiment were divided between a trough containing gravel and one without gravel. After over two months in these troughs the fish from the two environments averaged approximately the same in growth and survival rate.

Literature Cited

Babcock, John Pease

1911. Some experiments in the burial of salmon eggs—suggesting a new method of hatching salmon and trout. Trans. Amer. Fish. Soc., 40th Annual Meeting, Sept. 27-29, 1910, pp. 393-395.

Robertson, A.

1919. Hatching fry in gravel. Trans. Amer. Fish. Soc., Vol. 48, No. 3, pp. 146-156.

FISHWAYS

By John Spencer [1]

Prior to the development of the country and the utilization of the waters of the streams for man's benefit the fish were in practically undisputed possession of these waters and were free to proceed upstream as they desired, except where hindered or stopped by natural falls in the stream. As an aid in the utilization of the waters of the stream, dams were constructed and at first there was little or no attempt to aid fish in passing these barriers. This disregard for the need of fish, especially anadromous species, to proceed to the headwaters of the stream or to suitable stream beds for spawning purposes, resulted in the destruction of certain species and largely contributed to the depletion of others.

While the dams first constructed were generally low in height as compared to present structures, yet they frequently formed an impassible barrier to upward moving fish. As the water resources were increasingly utilized and developed, larger and higher dams were built, resulting in still greater detrimental effect on fish movement and life.

The damage to fish life by the construction of these dams could, in part, be overcome by the installation of fishways. Closely following early dam construction, laws were enacted which required the addition of these structures so that fish would not be prevented from proceeding to the spawning grounds.

A fishway (also called a fish ladder) is an auxiliary structure attached to or around a dam, which permits fish to pass by easy stages from near the downstream toe of the dam to the retained waters above. It may also be used for easy descent by the fish in their downstream journey, but the primary purpose is as above stated.

Fishways have been in use in this and other countries for many years. Some installations may be classed as satisfactory, or nearly so, but all too many have failed. It is difficult to determine the measure of efficiency that has been attained. Descriptions of design and construction have often appeared in print, but these have seldom been followed with data as to the effectiveness of the fishway operation.

It would seem that fishways can be classified under two general heads, mechanical and flow types. In the former the fish are trapped or induced to enter a compartment at or near the downstream toe of the dam and, without effort on their part, are elevated to the waters above. It appears that past attempts in getting fish over dams by mechanical means have generally failed, probably due in part to disregard for the instincts of the fish. It may be, though, that there are possibilities of use that have not been developed as yet. The flow type of fishway has a contained and directed flow of water from above the dam to the

[1] Mr. Spencer, now Chief of the Bureau of Hydraulics, California Division of Fish and Game, prepared this paper while in the employ of the United States Bureau of Fisheries. Permission to publish the paper in CALIFORNIA FISH AND GAME was kindly given by the United States Commissioner of Fisheries.

downstream toe or its vicinity, and on a gradient low enough so that fish are able to ascend without appreciable difficulty to the waters above. This type seems to more nearly approach natural stream conditions and is effective within limits.

The subsequent matter contained herein is based on the writer's experience and observation of Pacific Coast conditions and in the main is with reference to the passing of trout and salmon. It is believed that these conditions are similar, or nearly so, in other sections of the country although some changes and adjustments may be necessary in fishway design.

While there are certain fundamentals that are to be carefully considered if an effective structure is to be had, it should be realized that each dam and its required fishway is a distinct problem by itself and must be so considered, and hence the design for a fishway may only be prepared after a complete study of all known data and an inspection of field conditions.

When the need of a fishway is being considered for a dam which is in place or contemplated, study should be made of the species of fish in the stream which will use it in their natural life cycle. Trout have a tendency to move to headwaters for spawning purposes and this upstream movement is necessary for anadromous fish, such as steelhead, shad and salmon. For certain other fish a dam is of no significance except as it may deprive them of desirable feeding areas. If there is sufficient movement of fish and enough spawning area above the dam to justify fishway construction, the other factors controlling design may be considered. Some dams and diversions may be of such design, or so operated, that they will in various ways so adversely affect fish life that fishway installation is unwarranted.

When it has been found that a fishway is required, detailed study must then be made of the species of fish that it is desired be passed over or around the dam. As the fishway is generally for all the different species in that stream, it is necessary that it be designed to permit the least energetic or able fish to reach the waters above the dam.

Some dams require more than one fishway, because the width of the stream, operating practices, or type of construction may tend to form separate channels or pockets, or all the different species may not be accommodated by a single installation.

Efficiency and economy will best be served if the fishway is made a part of the original dam design. This procedure necessitates cooperation between the representatives of the conservation agency and the designers of the dam. The fishway design will be based on results of studies of stream flow, heights of water in the reservoir, fluctuations and time intervals, maximum and minimum flows over the dam and when they occur, probable action of water below the dam, proposed operating practices when the dam is placed in operation, and maximum quantity of fish that will use the fishway at any one time. Consideration should also be given to possible changes in operating practices and their effect on fishway operation. The design should be sufficiently flexible to provide for such occurrences. Other factors which will be noted later should also be given careful thought. It is evident that if the conservation agency representative is to intelligently cooperate and

design a fishway, he should have engineering knowledge and water operations experience in addition to his other qualifications.

Data are generally available when designing a fishway for an existing dam. Records show stream flows, operating methods, water levels and other details. In addition, movements of fish at the base of the structure may sometimes be observed. The physical features, however, may be such that the proposed fishway installation is much more difficult and expensive when built afterward than if it had been included in the original construction.

The location of a fishway is important, especially its entrance. This should be at a point in or near the immediate vicinity of the line of travel of the fish, or where they usually congregate, and also must be close to the base of the dam and yet avoid too much of the overpour from the dam. At times the lower pools of the fishway may be submerged but some portion of the fishway should be readily accessible to the fish. If a power house is a part of the dam structure, or reasonably close, it may be that the fishway entrance can be near the power house tailrace. More than one entrance to a fishway may at times be desirable or necessary.

A location favored in some localities is somewhere on the dam and removed from the abutments, the thought being that an installation at such an inaccessible location will obviate tampering with the fishway and the removal of the fish. That is probably correct to an extent, but the disadvantage of this position is the difficulty of any adjustment during high waters and when fish are attempting to pass. Debris may lodge there making it inoperative, or partially so, for a time. It appears to the writer that the disadvantages of such a location are in excess of the benefits, though if fish naturally congregate in midstream difficulty might be encountered in diverting them to an entrance at or near the abutments.

The exit of the fishway into the waters above the dam should preferably be where the velocity of the water is low, and at a distance, if possible, from outlets or diversions. It should be protected from moving debris so that the waterflow through the fishway will not be interrupted and the fish not hindered in leaving the fishway.

With the entrance and the exit fixed, the designer now determines the type of fishway to connect these two points. The simplest design is to be preferred, one that will require the minimum of attention and maintenance, and yet be accessible to fish. The pool type of fishway appears to be reduced to the barest essentials and has been found satisfactory for trout and salmon. It is believed that this type may be satisfactory for less active fish, since carp and suckers have been observed proceeding upwards to a height of forty feet.

The pool type consists of the required number of boxes or pools, each higher than the preceding one by a determined distance (generally from 1 to 2½ feet), joined together in line with flowing water and direction of moving fish, and each having a stationary depth of water greater than the difference in elevation between the pools. Some pool types have the water flowing over the entire width of the end of each pool. This appears to be the general practice where there is an unlimited water supply, but when water is limited ports are an advantage.

5—46325

The typical fishway has the ports on one side, thus giving a more uniform flow of water, obviating cross-currents in the pool and providing a greater area of quiet water for fish to rest in before proceeding to the next higher pool (see figure 32). The stationary water height is increased by the depth of the water flowing through the ports. The sides of the boxes are higher than the water level by three feet or more, depending on the size and species of fish using the device, to prevent fish from jumping out of the pools. The outside wall adjacent to the port is continued at the same elevation for a distance of about four feet on the next lower pool, forming an additional guard. It is desirable to have the water fall as close to the dividing wall of the pools as possible, and the thickness of the wall should be kept to a minimum. The pools should be ample in area so that no congestion will occur even during the heaviest movement of fish.

The difference in elevation between pools (jumps) is determined after considering the different fish to be passed, distance and obstacles overcome by the fish prior to arrival at the fishway, water conditions, available construction area, and general practicability of the proposed structure. For fishways of some length and height it is advisable to insert one or more larger pools which will serve for resting areas for the fish in their upward journey.

A regulated and even flow of water through a fishway is to be desired. Too great an amount will unnecessarily tire the fish. As the water level in the reservoir may fluctuate rapidly at times, it is necessary to regulate the flow either manually or by mechanical means.

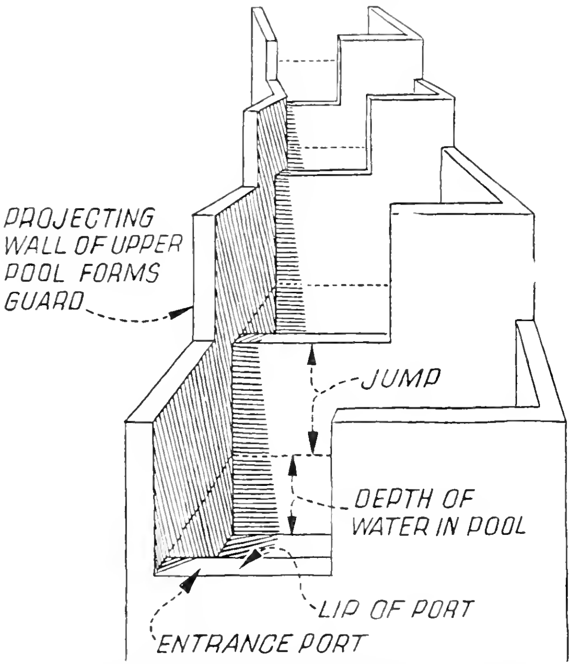

FIG. 32. Diagramatic drawing of typical fishway, looking upstream. The principal features of the fishway are shown as they would appear when no water is flowing.

Where regulation will be required the maximum and minimum water levels of the reservoir are determined and this difference in elevation is distributed equally through the upper pools (counting down-stream from the exit), the determined jump from each pool not being exceeded for high water level in the reservoir. To accomplish this the floor of these upper pools is at the low water level regulation point, and in lieu

of the normal dividing wall between pools, check boards are used. These are adjusted for the proper heights or jumps, and also to permit of the desired flow of water for the different water levels in the reservoir. For mechanical regulation the construction in general is the same, but the ports or checks are operated mechanically.

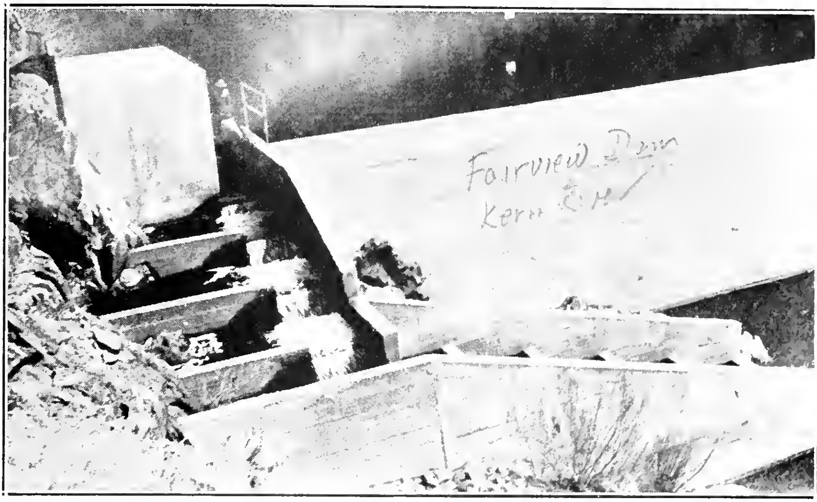

FIG. 33. Fishway of concrete construction with a natural rock bank forming bottom and portion of one side. A float at the upper port regulates the amount of water flowing through the fishway.

Where there is no overpour from the dam the fish generally find the entrance of the fishway without difficulty. Intermittent flows over the dam may complicate fishway operations. Sometimes an auxiliary water supply carried directly to the entrance pool may be needed to attract the fish and induce them to enter the fishway. In streams where the fish move at well defined times, and where the supply of water is limited and valuable, it may not be necessary to pass water through the fishway except in these defined periods, although water flow in a stream at all times is of value.

The fishway may be constructed of lumber, masonry or concrete. It should be built to withstand severe high water conditions. The topography and natural formation may be utilized to good advantage, but the depth of water in the pools in the line of travel should not be lessened by any projecting rocks. A small opening on the floor and connecting the pools is desirable for draining and cleaning purposes, although it should be removed from the general line of travel so as not to form cross-currents or disturb the fish if they desire to rest on their upward journey.

Changes in the direction of the fishway should be kept to a minimum, but where they are necessary it will generally be of advantage to have larger and deeper pools. Comments that a fishway must have ample light may be correct, although it is known that salmon and trout have used fishways that were under the back face of a dam where light penetration was limited.

The writer is of the opinion that data are insufficient at this time to definitely say to what heights fishways may be constructed and be fully effective for certain species of fish. Some species are more energetic and better able to pass barriers than others. A fishway which has a total difference in elevation between entrance and exit of 70 feet has been entirely effective in passing all steelhead, the only noticeable species in that stream. The pools are 6 feet wide and 8 feet long. The depth of water is from 2 to $2\frac{1}{2}$ feet, and the difference in elevation between pools (jumps) is $2\frac{1}{2}$ feet. Two resting pools are provided. While the steelhead appear to have no difficulty in passing this dam, it is believed that larger pools, greater depth of water, and better placing of ports would be of advantage.

Designs of fishways to be used by salmon generally provide larger pools and greater depth of water than if only steelhead are being considered. This is necessary because salmon are larger, and probably not as energetic and capable of sustained effort in a fishway, and also because salmon should not be required to use up all of their energy in passing a dam but have sufficient remaining strength to complete their journey and life cycle. For salmon fishways it is believed that the maximum jumps should not exceed $1\frac{3}{4}$ feet and should preferably be less, especially if the fishway is of any appreciable height. Topography and other physical features may necessitate exceeding this figure for a limited number of pools at times. It is desirable to have all jumps in a fishway equal in height. Salmon fishways are in successful operation to heights of 60 feet, but with proper design it is believed that this is not the limit.

The inclined plane system of fishways has baffles so set in a flume that the water takes a long sinuous course, thus reducing its velocity. For low dams these may be satisfactory, but it is believed that for dams of any height the pool type previously described will be more effective and economical and require less effort on the part of the fish.

The Cail type of fishway is, for practical purposes, the same as the pool type with the addition of an orifice on the floor level and in the cross wall between the pools. Fish which do not desire to jump over the cross wall or port may swim through the orifice. For fishways with relatively small pools the writer has found that these orifices or lower openings were disadvantageous, as cross-currents were produced which hinder fish movement. When the fishway was altered to the distinct pool type, salmon proceeded upward more readily.

NOTES ON SARDINE GEAR CHANGES AT MONTEREY[1]

By J. B. Phillips,
California State Fisheries Laboratory,
Division of Fish and Game

During the 1936-1937 season, 93 different boats delivered sardines to processing plants in the Monterey region.[2] Only 75 of these boats can be considered as permanent; that is, they operated for 2½ months or longer. The other 18 boats can be considered as temporary; that is, they operated for less than 1½ months. Most of the temporary boats made only a few deliveries. Fifty-one of the 75 permanent boats were purse seine boats. Two of these were equipped with ring nets and carried no turntables. Ring nets are similar to purse seines in construction but differ mainly in that lighter weight webbing is used, and the ends of the net are tapered instead of square. The balance of the permanent boats, 24 in number, were launch and lighter combinations, all equipped with ring nets. Of the 18 temporary boats, 12 were purse seine boats and six were launch and lighter combinations.

The average hold capacity of the purse seine boats was 90 tons and the average lighter capacity of the launch and lighter combinations was 55 tons. The range of hold capacities for the entire purse seine fleet was 40 to 155 tons. The average hold capacity of the purse seine fleet during the 1936-1937 season was 14 tons greater than for the 1935-1936 season. The higher average hold capacity of the purse seine boats was due to a number of new locally owned boats of large capacity; eight of the boats that fished for the first time during the 1936-1937 season had hold capacities between 115 and 155 tons.

Thirty-four of the permanent fleet of purse seine boats were locally owned, 12 were chartered, mainly from Washington waters, by local crews, and five were outside boats with outside crews. All of the launch and lighter combinations were locally owned, survivors from previous years when the lampara net dominated the Monterey sardine fishery. Many of the former operators of these combinations now operate purse seine boats.

Purse seines averaged 190 fathoms long, or 10 fathoms more than for the previous season, 1935-1936. This was due to a greater number of larger boats. Ring nets of the launch and lighter combinations averaged about 138 fathoms in length, or within two fathoms of the previous season's average.

Many purse seine boats have discontinued the use of power on the turntable roller. It has been found that when power is applied to the roller, the net can not be pulled in as fast as the roller revolves, and

[1] Submitted for publication March 17, 1937.

[2] All but one of the sardine plants in the Monterey region are located at the town of Monterey. The one exception is located at Moss Landing, about 18 miles to the north of Monterey. This plant commenced operations in 1935.

this friction harms the net. The boom and rope-sling tackle that is used to haul aboard the bunched purse-rings, is also used to haul up slack net. This saves a great deal of time and labor when a water-haul is made. The washing and tanning of these heavy nets are simplified by the use of the boom and rope-sling.

Floats or ''balloons'' were universally adopted by the Monterey fleet of purse seine boats during the 1936-1937 season. The boats were equipped with five to ten of the floats, which were either entirely of rubber or with a canvas covering outside and a rubber bladder inside, filled with air. The all-rubber floats are preferred. These floats are between 16 and 24 inches in diameter. They are snapped along the cork line at intervals, while the net is being pursed, to prevent the cork line from sinking. An outside boat that made one delivery at Monterey was equipped with several metal floats. However, metal floats are not desirable because they are heavy and also bulky to stow away when not in use.

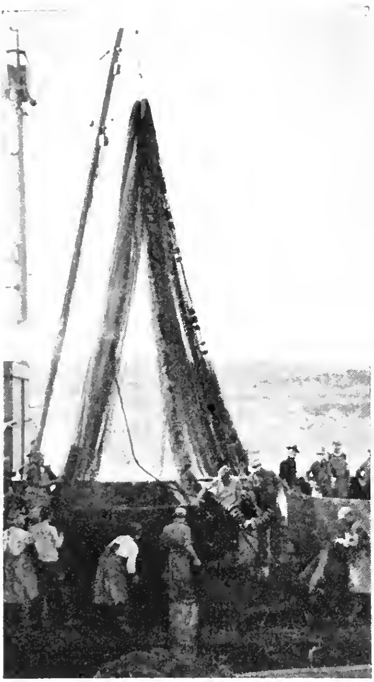

FIG. 34. The process of transferring a purse seine from boat directly into a tanning vat on Fishermen's Wharf, Monterey. The cork line is piled on the raised platform outside the vat. Note the use of the boom on boat for lifting a section of the heavy net. This arrangement is also used on the fishing grounds for lifting the bunched rings and slack net aboard the boat. Photograph by author, December, 1936.

Nets are preserved either by tanning them or tarring them. Some fishermen prefer one method, some the other. During the 1934-1935 and 1935-1936 seasons there were more tanned than tarred purse seines. The difference of opinion seems to be settled by a compromise—the fishermen now treat their nets both ways. The webbing of most of the purse seines used in the 1936-1937 season was tarred initially, and then tanned a few times during the season. This practice was started by a number of Monterey boats that went to Oregon to fish during the past two summers. Since there were no tanning facilities for the large nets at the Oregon ports, crews owning tanned nets tarred them before leaving Monterey.[3] When replacements were made with tanned webbing at Monterey, it was found by direct comparison that the tarred sections stood up better than the tanned sections. The main argument in favor of the tanned purse seine is that it is lighter and easier to handle, and has longer lasting qualities than a tarred net. However, the long length of life depends upon frequent washing and tanning (preferably twice a month) which is not always attended to, especially during inten-

[3] During the summer of 1936, a tanning barge for purse seines was constructed in Coos Bay.

sive fishing. When a net is tarred, the washing and tanning are not so imperative. The tanning can be done when convenient.

Tanning facilities for purse seine boats at Monterey have increased since 1934. Previous to 1934, any nets that were tanned had to be loaded on trucks and taken ashore. In 1934, a tanning scow was built, so that purse seines could be placed directly into a tanning vat from the boat. In 1936, another tanning unit was constructed, on Fishermen's Wharf, for the convenience of purse seine boats. Both of these tanning units are privately owned. In both cases, the tanning solution (chipped bark of the tanbark oak, plus water) is brought to a boil in a square metal tank, and then the hot solution is run off into a wooden vat that contains the net. There are two vats in the scow unit and three in the wharf unit. Each vat holds 4,500 to 5,000 gallons, and will accommodate one net. A net should remain in the tanning solution for at least five hours. Between 500 and 600 pounds of tanbark are required to tan a purse seine, and each batch of bark is used but once. The wharf unit used about 40 tons of tanbark during the 1936-1937 season. The charge for tanning was approximately $38 for a purse seine and $22 for a ring net.

SETTING AND SURVIVAL OF SPAT OF THE OLYMPIA OYSTER, *OSTREA LURIDA*, ON UPPER AND LOWER HORIZONTAL SURFACES [1]

By Paul Bonnot
Bureau of Marine Fisheries
California Division of Fish and Game

Oyster larvae, in common with the young of many marine invertebrates, pass through a free swimming stage. At the completion of this phase of their existence, with the proper combination of environmental factors, the oyster larvae attach themselves to some stationary object and remain fixed thereafter.

It is at once apparent, when studying either natural or artificial oyster beds that the oyster larvae, under normal conditions set much more abundantly on the under side of horizontal surfaces. The degree to which this occurs has been studied by Hopkins (1935) who found, "that more than 6 times as many larvae attach to under horizontal surfaces as to the under surfaces of glass supported at an angle of 45°, and about 100 times as many as caught on vertical surfaces." Oyster larvae normally swim with the velum uppermost. The foot, the organ most instrumental in setting, is adjacent to the velum. Hopkins says further, "Presumably in nature, as the larvae are carried along with the current, the foot may cling to a surface with which it comes in contact. This, most frequently, would be an under surface, and the more nearly horizontal the surface the more likely the contact. If the above described explanation of the habit of attachment to under surfaces is correct it would be expected that in places where the water is highly turbulent the larvae would frequently be turned over and would become attached to upper surfaces also."

Prytherch (1928, page 494) says of the setting of the eastern oyster, *O. virginica*, "The heaviest setting was found near the bottom and on the lee side of the collectors, presumably because of the eddies created by them."

The present paper presents the results obtained with a new type of spat collector, used for the first time in Humboldt Bay, California, during the season of 1936, by the Humboldt California Oyster Growers. Because of the construction and manipulation of this collector a condition was created which encouraged the swimming oyster larvae to set on upper as well as lower surfaces.

The collectors were made up of strips of plywood one-eighth of an inch thick, each strip having an effective area of 2½ by 22 inches. The strips were fastened together in groups of five by narrow pieces of plywood across the ends. The strips were spaced one-half inch apart.

[1] Submitted for publication March 31, 1937.

Four of the units, of five strips each, were nailed to two 5-foot lengths of redwood $\frac{3}{4}$ by 1 inch, with a 2-inch space between units. The completed section was dipped in a mixture of sand and cement and allowed to cure. The original idea was to obtain a maximum under surface by forming a battery of from 5 to 8 of these sections, one on top of the other. The flat surfaces were three-fourths of an inch apart (see figure 35).

The batteries were submerged in dikes, where even at low tide 6 or 8 inches of water is maintained. Comparatively long stakes were necessary to anchor the batteries to the bottom as they have a tendency to float and receive considerable pounding from wave action. The following results were observed: The surface facing the bottom, in most cases, took little or no spat, as almost without exception it touched the mud.

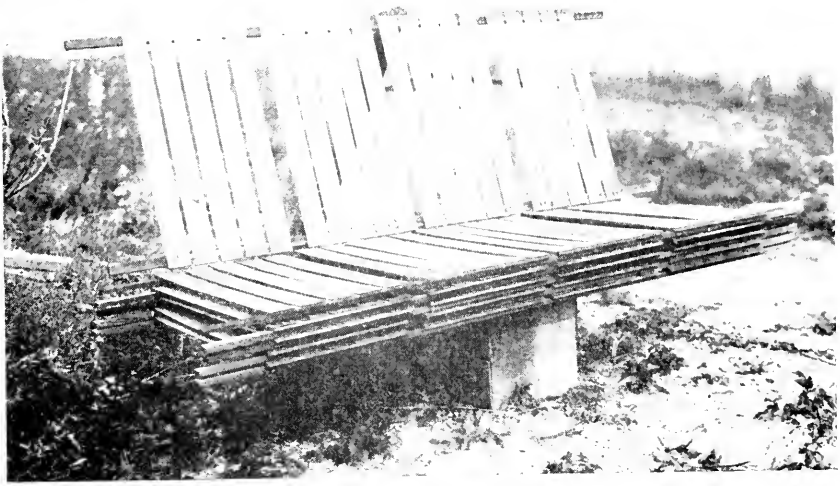

FIG. 35. Spat collector, not yet cemented, as used by Humboldt California Oyster Growers in Humboldt Bay. Photograph by Paul Bonnot, October 1, 1936.

The upper surface, on top of the battery, also took little. All other surfaces, however, took a heavy set of oyster larvae. Because of the fact that the individual batteries were spaced only 6 inches from each other the set was heaviest on the outside edges and became progressively lighter toward the center. One battery placed by itself at some distance from the others took an almost uniform set throughout. The set began about the 15th of May, reached a peak about the 15th of June and continued in progressively smaller peaks until the middle of August (Bonnot, 1937).

At the conclusion of the set fall, in August, it was estimated that the collectors had taken as many spat on the upper surfaces as on the lower. As the press of other activities did not allow time for an actual count, none was made, and when later it was deemed of interest to find

out what the percentage of spat on the two surfaces actually was, only a small section of a collector was available which could be accurately dated. On this piece, however, 14 square inches could be counted. As it was in the water for the approximate period of the setting time, June 1, 1936 to August 1, 1936, it gives a very good average of the spat fall (see table 1). On March 2, 1937, a unit of 5 strips was taken from the same dike from which the first section was obtained. It had been placed in the water on June 1, 1936. It was one of the end units of the second layer from the top of a battery. An area of 80 square inches was counted on this sample—one series of 20 square inches running across, and a second series along one of the outside strips. Each numbered square inch represents both an upper surface and its corresponding lower surface. In the case of the smaller section very few spat were dead. On the larger, very few dead shells were evident as they were probably over grown. The young oysters, in this case, were several times larger than those on the first piece. No dead shells were included in any of the counts.

TABLE 1

Spat Counts on Flat Collector, Put Out June 1, 1936, Taken Up August 1, 1936, One-inch Squares

Number square	Under surface	Upper surface
1	27	105
2	31	118
3	33	93
4	49	103
5	38	89
6	37	75
7	40	107
Totals	255	690
Average per square	36	98
Average percentage	27%	73%

The counts made on the small section of a collector, which was in the water for the duration of the set, and was therefore indicative of the intensity of the spat fall, showed an average of 98 spat per square inch on the upper surface, and 36 per square inch on the lower, or 73 per cent on the upper and 27 per cent on the lower. The average catch per square inch, taking into account both upper and lower surfaces, was therefore 67 spat. As the flat surfaces of the collectors are spaced only three-fourths of an inch apart and as the surfaces are comparatively rough because of their cement coating, considerable friction would be offered to a current, causing the water to roll and swirl. Under these conditions the swimming larvae would be carried along between the layers in all positions and it would seem logical that the slight pull of gravity would cause more of them to come to rest on the surface which was below them. Another very important factor is that this upper surface is almost entirely free of mud and silt because the narrow spaces tend to concentrate the flow of water and the swirling action washes the silt away, a condition not found in any other type of artificial collector.

The counts from the complete unit, which was left in position over the winter show a slightly different picture, although it is a logical

sequence based on growth (see table 2). A square inch of surface could not support more than 3 or 4 adult oysters, and as the average set per square inch was 67 it is obvious that unless the young oysters are removed several months after the set, the majority of them will be lost. At the end of eight months the numbers per square inch had already been drastically reduced, and although the upper surface started with a population three times that of the lower, the two surfaces were then approximately the same, with an average for both sides of 14.5 per

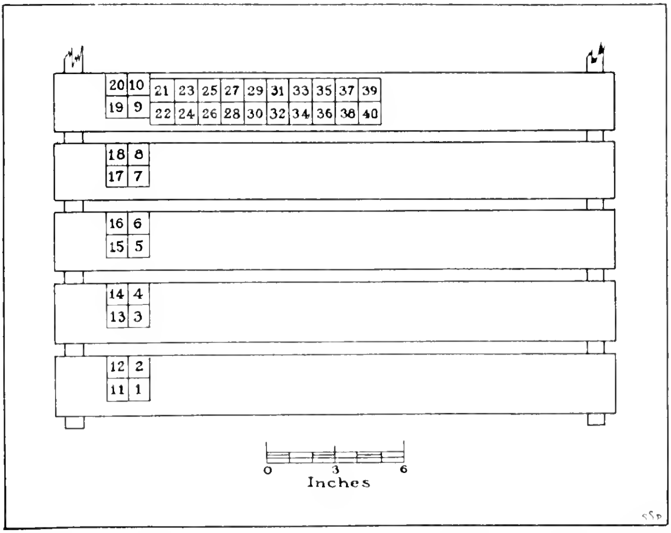

FIG. 36. Diagram of spat collecting unit, drawn to scale, showing position of numbered squares used in Table 2.

TABLE 2

Spat Counts on Flat Collector, Put Out June 1, 1936, Taken Up March 2, 1937, One-inch Squares

Number square	Under surface	Upper surface	Number square	Under surface	Upper surface
1	26	9	21	15	19
2	12	17	22	17	11
3	19	11	23	14	18
4	17	16	24	16	14
5	11	14	25	11	19
6	16	5	26	20	12
7	15	17	27	14	13
8	15	15	28	14	8
9	16	13	29	12	18
10	11	9	30	16	22
11	8	17	31	13	18
12	15	11	32	10	12
13	12	12	33	14	19
14	19	19	34	15	12
15	20	17	35	10	26
16	21	6	36	19	15
17	16	13	37	8	16
18	10	6	38	12	10
19	24	15	39	14	22
20	15	6	40	14	13
Totals	318	248		278	317
Average per square	16	12		14	16
Average percentage	57%	43%		47%	53%

square inch. If allowed to remain in situ it is probable that the oysters on the surfaces which face upward would all succumb, as the growing shells would gradually fill the spaces between the two layers of the collector, slowing the current and allowing an accumulation of mud and silt which would first smother the young oysters on the upper surface.

It would appear from the present demonstration that this system of spat catching is superior to any yet devised for taking oyster larvae, as the expectation per surface unit is more than doubled by the ability of the upper surfaces to catch spat.

Literature Cited

Bonnot, Paul.

1937. Report on the California oyster industry for 1936. California Fish and Game, Vol. 23, No. 2, pp. 163-173.

Hopkins, A. E.

1935. Attachment of larvae of the Olympia oyster, *Ostrea lurida*, to plane surfaces. Ecology, Vol. 16, No. 1, pp. 82-87.

Prytherch, H. F.

1928. Investigation of the physical conditions controlling spawning of oysters and the occurrence, distribution and setting of oyster larvae in Milford Harbor, Connecticut. U. S. Bur. Fish. Bull., Vol. 44, pp. 429-503.

THE CHUKAR PARTRIDGE OF ASIA[1]

By Gordon H. True, Jr.
Bureau of Game Conservation
California Division of Fish and Game

The chukar, *Alectoris graeca chukar*, is one of twenty-two varieties of a single species of partridge that is found from northern China and Mongolia, through India, Persia and Arabia to Asia Minor and southern Europe. In Asia, this partridge ranges as far west as the Holy Land, and in Europe to the Alps and middle and southern Italy. The species, or rather group of closely related varieties to which the chukar

FIG. 37. Because of its protective coloration the chukar partridge can easily escape detection. There are four birds in the cactus garden shown above. Photograph by August Bade.

belongs, has a well-known relative in the person of the "Frenchman" or red-legged partridge of Europe, *Alectoris rufa rufa*, and another in the Barbary partridge, *Alectoris barbara barbara*, of the desert plains of North Africa.

The partridge which has been introduced into California is the Indian representative of this family of game birds and finds its optimum range along the southern slope of the Himalayas from Nepal to eastern Ladakh. The stock from which our chukars were obtained came to us from Calcutta, India.

---

[1] Submitted for publication June, 1937.

The chukar presents a striking appearance with his red beak and feet, black necklace around a white (sometimes buff) throat, and the handsome vertical bars of black and brown on his grey flanks. When seen in his natural surroundings, however, he blends so perfectly with the background that he may escape detection by the keenest observer through the simple expedient of just "sitting tight."

In choice of habitat, the chukar is one of the most versatile of birds. Hume, in "Indian Sporting Birds," states that, "in one place it faces a noonday temperature of 150 degrees F., in another braves a cold, about daybreak, of a little above zero: here it thrives where the annual rainfall exceeds 100 inches, and there flourishes where it is practically arid." Apparently the only climate that a chukar can not stand is the incessant damp of a rain forest. It is found at altitudes ranging from sea level to 16,000 feet. To quote again from Hume, the chukar is equally at home "on open grassy hillsides in the hot, low valleys; on stony screes covered with a light growth of barberry bushes and amongst snows at 12,000 feet." It is this ability of the chukar to survive under such a variety of conditions that has encouraged its introduction into California—a land of contrasts where this bird must certainly find a favorable environment.

In India, the chukar breeds in April or as late as September, depending on the altitude. A pair of birds will naturally take up housekeeping much later at an altitude of 16,000 feet than they will at a 1000-foot elevation. The nest is built in a hollow scratched in the ground which may or may not be lined with grass or leaves. The nest may be built in the open or in the protecting shelter of a stone or bit of herbage. Sowerby in "A Sportsman's Miscellany" remarks that the nest "is very hard to find, usually being carefully hidden amongst the boulders and scanty scrub at the base of cliffs or in narrow ravines and gorges." A chukar hen will lay on the average a clutch of fourteen eggs. The eggs are yellowish white and speckled to a varying degree with brown.

Sowerby states that "young hatched in June are fully fledged by the end of August. By September the chukars are fully grown and ready for shooting." During the fall months, the pairs with their rapidly maturing young gather into coveys of from thirty to several hundred birds. They remain in coveys throughout the winter, breaking up into pairs at the beginning of the next breeding season.

The food of the chukar consists of reeds, small fruits and berries, leaves, green shoots and some types of roots. They also take insects and insect larvae when they are available. Chukars are very fond of cultivated grains but seldom enter fields in which crops are standing. They prefer to glean in the open fields after the harvest.

Hume says that the chukar flies strongly, making downhill when flushed, but will lie after one good flight. All one needs is a good bird dog to have a perfect day's shooting. Observations made here in California, though very limited, corroborate the above statements. A covey of chukars was flushed in the middle of a brushy flat in San Bernardino County one fine day, about a month after they had been liberated from the Chino Game Farm. The birds, fourteen in all, sailed away to a point about two hundred yards distant and alighted on the ground. The observer hurried to the spot to find that the birds had disappeared

and ten minutes of concentrated looking and listening offered nothing in the way of a clue to their whereabouts. Still standing in the same spot, the investigator idly kicked at a small shrub a foot or so from his right toe and literally fell over backward when the shrub disgorged fourteen chukars, going at full speed in fourteen different directions. They lie close and come out fast.

Those who have been lucky enough to eat the chukar partridge properly cooked and served maintain that here is a table bird second to none. The young birds, distinguished by their black bills, are, of course, the best eating.

Chukars have been liberated in twenty-six counties in California since 1932, the year during which the first liberation was made. The heaviest plantings have been made in the southern part of the State due to the fact that there is in that region a vast area of arid land which is not now occupied by game species, and to which it is felt the chukar will adapt itself, thus putting formerly useless land to work for the sportsmen. Naturally, the chukar can not yet be hailed as a permanently established resident of our State. It can, however, be said of this new bird that it looks good.

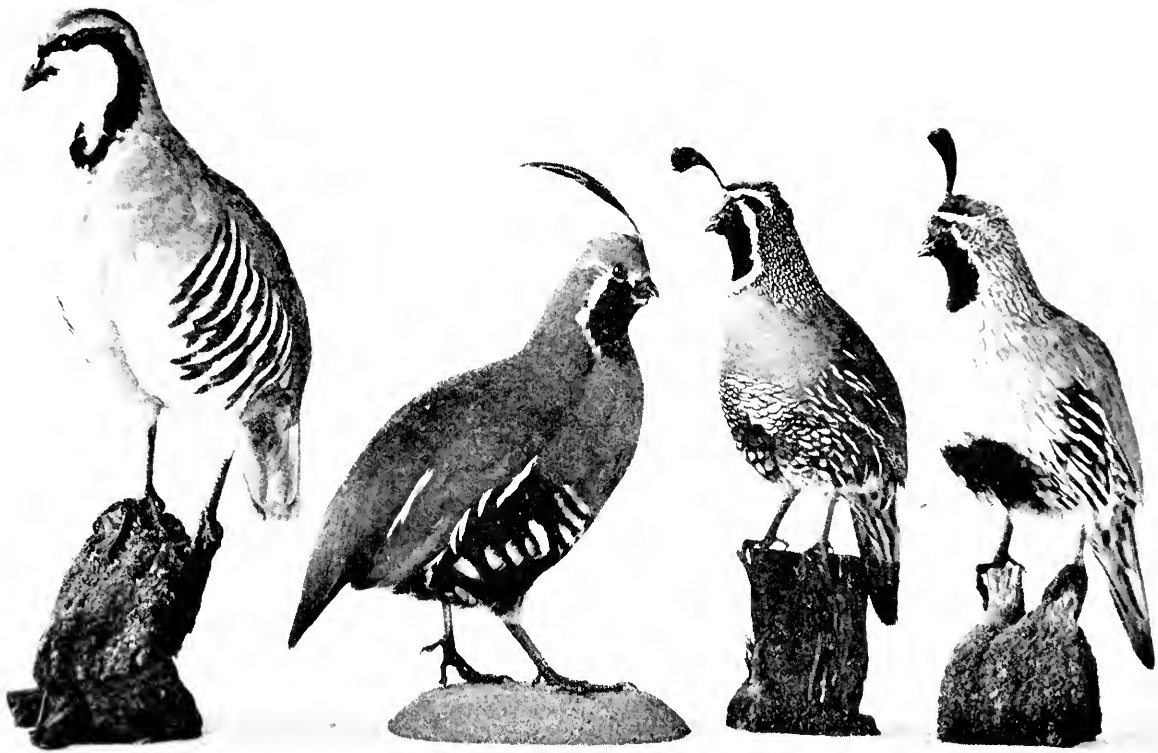

FIG. 38. Upland game birds; left to right, Chukar partridge, mountain quail, valley quail and desert quail. The Chukar, introduced from Asia, is being propagated and distributed in barren and mountainous regions of California where other game birds are scarce. The mountain quail, as its name implies, inhabits brush and forest lands in the mountains of California. The valley quail, the official bird of the State, is found in the valleys and foothills. The desert quail is a denizen of the arid southeastern part of the State. Photograph by Lee Passmore, reproduced through his courtesy.

THE CHUKAR PARTRIDGE IN CALIFORNIA [1]

By August Bade
Superintendent of State Game Farms
California Division of Fish and Game

Before the advent of civilization, California had an abundance of game birds, but their numbers have decreased alarmingly. The principal native upland birds included sage hen, blue grouse, valley quail and mountain quail. Of these, only the "king of the chaparral," the California valley quail, remains in goodly numbers.

Several years ago it became apparent that something had to be done to restore hunting. As a beginning, the ring necked pheasant was introduced into agricultural sections. While this stocking of pheasants was going on, a careful survey of the State was made to find out just what we had in the way of natural habitat for other upland game birds. Within California is found every conceivable climatic condition and habitat range—miles of coastal area, vast irrigated valley stretches and high mountain territory, as well as thousands of square miles of desert. The most particular or fussy bird can find the counterpart of its natural home some place in our State. In fact, the survey showed that we had ranges suitable for several kinds of pheasants, partridges, quail and turkeys. At the same time we began casting about for suitable birds.

In selecting a bird for introduction, the uppermost questions are, will it fit into our program as a game bird, and can it be reproduced artificially? Both of these points are important. Furthermore, in order to make a successful transplanting it is quite necessary to know in more or less detail the natural habitat of the bird under consideration. If this habitat can be duplicated there will be very little trouble in establishing any imported species. The ring necked pheasant and the Hungarian partridge are outstanding examples to bear out this statement. In many places in the United States these two fine game birds have come to be looked upon as the chief source of upland game bird shooting.

In building up our California game bird propagating system we have recognized certain species of birds and discarded others. It is our opinion that if a bird is to stand up and make progress it must have certain characteristics. The birds must be able to reproduce in considerable numbers even in the face of adverse circumstances. In short, they must be smart. With good roads, good cars and firearms, plus an eager public, it is no time or place for dumb-bells.

The chukar partridge seems to qualify as a desirable bird. It is smart and has the added advantage of its camouflaged color scheme. Those black stripes along its sides, as well as its red legs and bill, cause it to blend into almost any kind of cover. Imagine these birds in a habitat where granite rocks predominate. They become invisible in

[1] Submitted for publication March, 1937.

such surroundings and are only seen as they take wing with a whir and a burst of speed equaled by few game birds.

We have said that the game bird of today must be smart and capable of being reproduced artificially. In my estimation, and this appraisal is based on several years' experience with the birds, the chukar partridge is the answer to the sportsmen's prayer and the realized hope of the game breeder.

During one season at the Yountville farm we had two hens that laid 106 and 112 eggs respectively. A year later another female, possibly an offspring of one of these high egg producers, began laying on the 10th of March and kept on laying till she had produced 136 eggs. She had not only laid a large number of eggs, but better still, over 95 per cent of them were fertile.

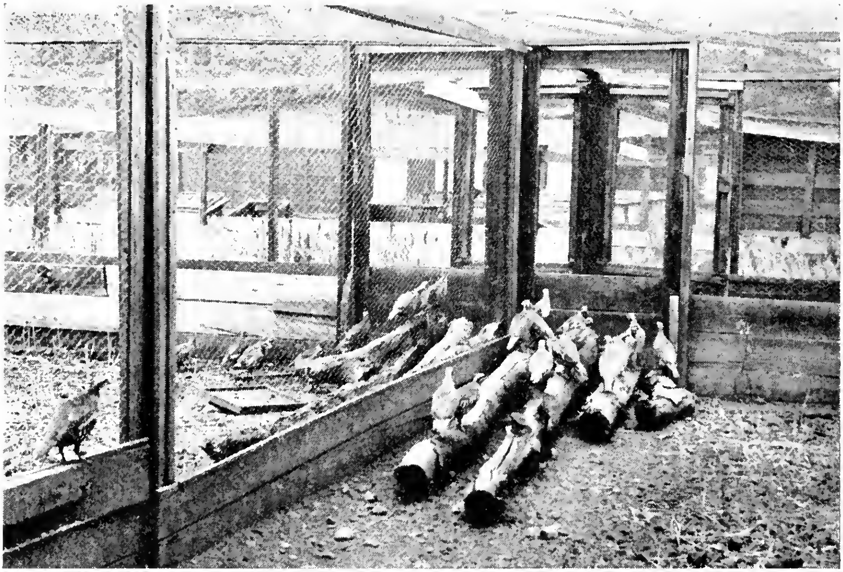

FIG. 39. Two-thirds grown chukar partridges in rearing pens at the Yountville State Game Farm. Photograph by August Bade.

As examples of what can be done in breeding chukars domestically, we can cite two examples. A retired business man of San Francisco took up game bird raising as a hobby. From 13 pairs of chukars this man reared over 400 birds to maturity. He raised these birds purely for table purposes. About the first of November he presented 30 of his club associates with six birds each. One of the recipients, a man who had always contended there was no table bird like the California valley quail, wrote me a letter in which he stated, "The chukar partridge is a better table bird than the quail."

Another man who had become interested in the chukar partridge, and wanted to reproduce them, obtained twelve pair as his foundation stock. The twelve females laid 980 eggs for the season. Although it was his first season as a game breeder he hatched out over 500 chicks and reared about 350 to maturity.

This egg producing quality and adaptability to domestic conditions are characteristics of the pheasant, quail and partridge, and are factors that make them especially valuable for restocking purposes. In contrast, many of our native species are very deficient in egg production—the first requisite of any game bird that is to play an important part in restocking programs of the future. They are not only low in egg production, but are very easily discouraged if their nests are molested during the reproducing season. On the other hand, the pheasant, partridge and quail are imbued with the idea of perpetuating their kind and they will usually do it if it takes them all summer.

The question naturally arises, will they behave before a dog? The answer is yes, and this information comes from men who have hunted them in their native habitat. In Asia, the chukar is a favorite game bird.

About two years ago a gentleman came to the Yountville Game Farm and inquired about chukar partridges, saying that he had read in a newspaper that we had some and he would like to see them. As he gazed at several dozen of them he remarked, "That is the same bird." He was a retired naval man and lived only a short distance from the farm. During his enlistment he was stationed at Shanghai for seven years. On several occasions during that period he was sent out on scouting expeditions. On one of these trips he and his party went up the Yangtze River and into the back country of Mongolia. At times, he said, they lived on the meat of the chukar for weeks, and here is the most significant statement of all—"Don't let any one tell you that the chukar partridge isn't the best eating bird in the world."

Our experience with the chukar dates from 1928. At that time our department purchased five pair. At least they were supposed to be five pair. We secured these birds late in the season and gave them little attention on account of a heavy pheasant and quail program. By the next season we had time to study and observe them. Five more "pair" were secured direct from Calcutta, India. These five pair turned out to be nine males and one female. But with what we had reared the first year we now had enough to start a foundation stock. At the close of 1936 we had reared and released 4600, and we have over 600 for breeding stock in 1937.

The proof of the pudding is in the eating, so the saying goes. What proof have we that the chukar partridge is making good and reproducing in a natural state? In California we have found the nests, made pictures of nesting females, checked the young birds in several stages of development and otherwise watched their progress. These birds have been released in about 80 different sections of the State under many different altitude and climatic conditions. In no instance have the birds disappointed. Two or three examples, selected at random, indicate that the chukar is here to stay.

In Siskiyou County, fifteen pair of birds were released in March. No other chukars have ever been released in that locality. The following December over 90 partridges were counted in that area. On one ranch in Kern County the riders reported finding five nests in the month of May. In this particular area about 15 pair of birds had been released.

So far as California is concerned we think the chukar is a valuable game bird as it takes well to the more arid and desert-like areas. In fact it is living up to its reputation as "the bird that lives on nothing." As a matter of record we have had them reproduce on the Mojave Desert. In Kings Canyon, Los Angeles County, a nest of ten eggs was found. The eggs hatched on the 13th day of August, 1935. If there is any hotter, dryer place on the face of the earth, especially in the month of August, we do not know where it is. Any bird that can breed there has a place in California.

From our experience with the bird in California I would say they do best in a dry climate where the altitude ranges from 1000 to 4000 feet. We are using them to stock the more or less barren and wasteland sections of the State where at the present time there are no game birds of any kind.

When considered from every angle it seems to be the best bird for our State that it has been our good fortune to handle—a good producer under domestic conditions, a fine game bird, and the bird supreme as a table delicacy. What more could one wish? May this fine game bird continue to meet with favor and do its part in rebuilding the upland game bird supply of our country.

CALIFORNIA'S JUNIOR GAME PATROL[1]

By M. F. Joy, Jr.
Warden, Superintendent Junior Game Patrol
California Division of Fish and Game

The Junior Game Patrol was first organized in 1936 by the Division of Fish and Game because of the need for educating society in the principles of conservation, so that the Division's work in the preservation of California's resources for the benefit of the public may not be in vain. The number of violations of the fish and game laws in California since 1926 has increased greatly, and it was apparent that a large proportion of the violators were young men between the ages of 21 and 30. The purpose of conservation is to assure the constant use of the resources and to leave a sufficient breeding stock, and the fish and game laws are therefore enacted by the people of the State to aid in the management and wise utilization of the resources. Hence, the Bureau of Patrol of the Division of Fish and Game is vested with the duties of enforcement of these laws. The Bureau's aim is to make the public realize the significance of the inestimable damage that can be done through carelessness and of their responsibility in preserving Nature's gifts for future generations, and it is not the Bureau's sole purpose to apprehend violators as so many are prone to believe. This is in keeping with the modern trend to prevent rather than punish. For example, since 1926, there have been 23,345 persons arrested and convicted for fish and game violations in this State, but many of these offenses could have been prevented. Fines for such violations amounted to nearly half a million dollars and the violators served some 70,000 days in jail, an aggregate of 191 years. Although it may be too late to educate the older people, we can do a great deal of good by teaching our youth the principles of conservation so they will not become violators.

A plan, originated and furthered by Mr. A. T. Jergins, Fish and Game Commissioner of California, was therefore initiated to educate our younger generation along these conservation lines, teaching them to appreciate and protect the wildlife, the perpetuation of which is in the hands of the public. Such was the origin of the Junior Game Patrol, which is making even more rapid strides than the Division of Fish and Game had anticipated. The sportsmen's organizations have aided materially in furthering this work by taking an active interest.

The Junior Patrol, under the direct supervision of the Division, is made up of troops, the members of which are boys of 10 to 21 years of age. Their membership is solicited throughout the schools, and the troops are locally sponsored by sportsmen's clubs, civic organizations or interested individuals. The sponsoring agency furnishes the required adult supervision, namely, troop leaders—one for each platoon consisting of 19 boys—and also special instructors whenever necessary. If the

[1] Submitted for publication June, 1937.

patrol leaders are adept in some particular phase of the program, such as natural history, specimen mounting, drilling, sport fishing, etc., their knowledge will be of benefit to the troop. However, in any case the officers of the Division of Fish and Game are prepared to instruct in specialized conservation fields in addition to directing the general activ-

FIG. 40. A Ranger of the Junior Game Patrol. The uniform is modeled on that of the Canadian Northwest Mounted Police.

ities. The sponsor of the troop provides a meeting place, which is usually a civic hall, school or other convenient place.

In organizing a troop, a group of boys is called together by the Division of Fish and Game and the purpose of the Junior Game Patrol is explained to them. The boys are given literature on fish and game

laws and on natural history subjects, and are provided with applications for membership. Weekly meetings are held thereafter. After four weeks of instructions on fish and game laws and the reasons for them, a preliminary examination is given. The successful boys take the oath of office and are given badges and credentials signed by the three California Fish and Game Commissioners and the Division's Executive Officer. Thus, they become Rangers of the Junior Game Patrol. Then they are ready to commence with the course of instructions, outlined below, which is made as interesting as possible. Field trips are an important feature, as it is only through actual contact

FIG. 41. The badge of the Junior Game Patrol.

with nature that the desired results can be secured. The course consists of the following activities:

Instructions in fish and game laws and the reasons for them.
Identification of birds, fish and other animals; mounting of specimens.
Drill work.
Fishing—fly and bait casting.
Making of flies and leaders, rewinding rods.
Hunting in field; dog training.
Hiking, camping, forest fire prevention.
Rifle and pistol shooting.
Trapping; predatory animal control.
Athletics.
Red Cross life saving.

Game management on the farm; restoration of cover for upland game; soil erosion.
Game bird raising.

The organization of the patrol is as follows:

Squad

1 Corporal	1
3 Rangers	3
	4

1 Platoon

4 Squads	16
2 Sergeants	2
1 Lieutenant	1
	19

2 Platoons
1 Captain

1 Company

4 Platoons	64
8 Sergeants	8
4 Lieutenants	4
2 Captains	2
	78

1 Troop
Any number of companies
1 Major

FIG. 42. The shoulder insignia of the Junior Game Patrol.

The Division of Fish and Game has designed uniforms (see Fig. 40) for these boys, and the cost is approximately $7.75 each. The sponsoring agency, if it so desires, may uniform the boys but the Division of Fish and Game recommends that the funds for their purchase be raised by the rangers themselves through social functions or other means. There never should be any financial obligation on the part of the individual member or his parents. In this way, the uniforms will be the property of the troop.

At the present time (June, 1937), there are approximately 250 members who have received their commissions. The average age of the boys is 15 years. Troops have been organized in San Francisco, Oak-

land, Tracy, Stockton, Napa and in Marin County, and sponsored by the following clubs:

Foothill Sportsmen's Club, Oakland
San Francisco Rod and Gun Club, San Francisco
Ingleside Sportsmen's Club, San Francisco
Daly City Sportsmen's Club, San Francisco
Tracy Wildlife Association, Tracy
Napa Rod and Gun Club, Napa
Marin Rod and Gun Club, San Rafael

FRANK F. MERRIAM, GOVERNOR

State of California

Division of Fish and Game

[Dated] FEBRUARY 2, 1937

By the Authority of the Fish and Game Commission

ALAN C. WILSON

of FOOTHILL JUNIOR SPORTSMEN CLUB

County of ALAMEDA, State of California,

is hereby constituted and appointed a

RANGER

of the

Junior Game Patrol

Fish and Game Commission

President

Executive Officer

FISH & GAME COMMISSIONERS · STATE OF CALIFORNIA ·

I will endeavor to be a good sportsman and work for the conservation of fish and game at all times. My aim will be to build my body and character clean, fine and sturdy, in keeping with the great out-doors.

Alan C. Wilson

FIG. 43. A Ranger's commission in the Junior Game Patrol, signed by the three Fish and Game Commissioners and the Executive Officer of the Division of Fish and Game.

The rangers are not vested with any law enforcement authority and it is not the intention of the Division to grant it. Above all, they are not to work in the guise of "stool-pigeons." They are taught conservation practices, to appreciate and protect wildlife, to be aware of the beauties of nature, to be sportsmanlike, and in general to become better citizens for having become rangers. These boys can carry the knowledge thus gained to their homes and associates and so spread the conservation movement. They will understand that violating fish and game laws and the laws of the forest is not smart or clever, but a dishonorable crime against nature. We know this work is worthwhile but we need the public's cooperation and assistance in order to make this "conservation through education" undertaking a Statewide organization.

EDITORIALS AND NOTES

VOLUME 23 JULY, 1937 No. 3

BUREAU OF MARINE FISHERIES

The Fish and Game Commission, at its meeting on June 19, 1937, ordered the name of the Bureau of Commercial Fisheries changed to Bureau of Marine Fisheries, as it was believed the new title more nearly fits the functions of the Bureau. This change, in name only, became effective July 1, 1937.

FIG. 44. One of the two new fisheries patrol cruisers placed in service by the Division of Fish and Game in June, 1937. Photograph by E. L. Macaulay, San Francisco, California.

TWO NEW PATROL BOATS PLACED IN SERVICE

The marine fisheries patrol in southern California waters has recently been increased by the assignment of two new cruisers, the *Marlin* to San Diego, and the *Bonito* to Santa Barbara. These boats, commissioned on June 12, 1937, are 45 feet long, with 10-foot beam, and are powered by twin screw gas engines capable of developing a speed in excess of 25 knots when necessary. They have sleeping accommodations for two men and sufficient fuel tank capacity to permit them to make distant trips from their home stations.

The *Marlin* and the *Bonito* cost approximately $12,000 each, with complete equipment. This is considerably more than the cost of the *Yellowtail,* a boat of similar type and construction which was placed in service September 21, 1936, and is stationed at Newport.—*E. L. Macaulay, Chief, Bureau of Patrol, Division of Fish and Game, June, 1937.*

B. D. MARX GREENE

B. D. Marx Greene, former Executive Officer and Attorney of the Fish and Game Commission, died at San Francisco on February 20, 1937. His death came as a great shock to his many friends in California.

Mr. Greene was appointed to the position of Attorney on August 21, 1924. He served in that capacity until January 18, 1926, at which time the offices of Executive Officer and Attorney were combined. He was appointed to both offices and held them with distinction until his resignation on December 1, 1927. During his term of office the Division of Fish and Game was reorganized, and he instituted many beneficial changes which are still in effect. He will long be remembered for his progressive term of office.

At its meeting on April 10, 1937, the Fish and Game Commission unanimously adopted the following resolution:

> WHEREAS, In the death of B. D. Marx Greene, former Executive Officer and Attorney of this Commission, the State has lost a man who rendered outstanding service in behalf of fish and game conservation; and
>
> WHEREAS, The Fish and Game Commission wish to give recognition of the valuable services rendered by the deceased while in the employ of the Commission; be it
>
> *Resolved*, That an expression of sympathy be incorporated in the minutes of this meeting and that a copy of such resolution be mailed to the bereaved family.

—*Richard S. Croker,*
Editor, "California Fish and Game"

THE MOLLUSKS OF LAKE TAHOE

Lake Tahoe, one of the largest lakes in the western United States, lies near the crest of the Sierra Nevada on the California-Nevada boundary at an elevation of 6225 feet. It catches the drainage from a considerable area close by but has no large inlets. It drains to the north, then east by Truckee River, which in turn empties into the closed basin of Pyramid Lake, Nevada.

For many years it has been known that there are a few species of fresh-water mollusks in Truckee River,[1] but so far as we have discovered Lake Tahoe is without a record. This seems strange in view of the size of the lake, and the purity of its waters and the number of conchologists who have visited it. Many have made fruitless search of its shores and shallow waters. Several attempts by us indicated that this was not the proper method for collecting if the lake were not barren. This seemed inconceivable because other conditions were such that mollusks could hardly be absent.

Reasoning from analogy with similar large lakes it seemed possible that in this case also these animals would be found in relatively deep water. Therefore a dredge was taken to the lake in October, 1933, and several hauls were made in depths up to 50 fathoms off Chambers Lodge on the west side. In every case beyond 20 fathoms, shells were found among the water plants which came up. This procedure was

[1] Carleton, Henry P. Shells of Truckee River and Vicinity. Proc. Calif. Acad. Sci., Vol. 4, 1869, p. 57.

followed on August 13, 1936, with equally good or better results in 30 fathoms off Homewood Resort.

The discovery of shells and the names of the few species found seem worthy of record. These are: *Pisidium sp., Parapholyx effusa* (Lea), *Carinifex newberryi* (Lea), *Valvata humeralis californica* Pilsbry, and *Lymnaea sp.*

Undoubtedly additional species will be found when more thorough dredging is undertaken. Tracks and furrows in the white sand off Chambers Lodge resembled those made by *Anodonta* but no specimens or fragments were obtained.

The above, however, were not the first shells actually collected in the lake. During the interval from December, 1926 to March, 1927, James Moffitt collected six lesser scaup ducks there which had fed on mollusks. The stomach contents of these birds were 100 per cent animal matter; a very considerable part of this consisted of fragments and entire shells of *Carinifex newberryi* (Lea). The identification was made by E. R. Kalmbach of the U. S. Biological Survey.—*G. D. Hanna and A. G. Smith, California Academy of Sciences, June, 1937.*

A SILVER SALMON AT LOS CORONADOS ISLANDS

On June 20, 1937, a party boat was fishing near Los Coronados Islands which are out from San Diego and just south of the international boundary line between the United States and Mexico when one of the party trolling an aluminum jig hooked a silver salmon, *Oncorhynchus kisutch*, estimated to weigh between 9 and 10 pounds. The fish was examined by N. B. Scofield, H. B. Nidever and the writer on June 21 and there was no doubt as to the identification. This, so far as we know, is the southernmost record of the occurrence of this fish along the Pacific Coast.—*W. L. Scofield, California State Fisheries Laboratory, June 23, 1937.*

MONTEREY SPANISH MACKEREL TAKEN AT LONG BEACH

A specimen of the very rare Monterey Spanish mackerel, *Scomberomorus concolor*, was taken at Long Beach, California, on May 20, 1937. It was caught on hook and line, with a live sardine for bait, inside the harbor. The present specimen, a two-foot female containing ripening eggs, is the second fish of this species to be reported from southern California.

As its name suggests, the Monterey Spanish mackerel is found most often at Monterey, California. Or rather, it used to be found at Monterey—for it disappeared from sight nearly 50 years ago, and only two specimens have been reported there since. From 1870 to 1890 it was fairly common in Monterey Bay, and commanded a high price on the market. About 1890, the fish vanished for some inexplicable reason. Since then only a few have been recorded anywhere. Boulenger reported its occurrence (as *Cybium concolor*) in the Gulf of Panama, but he did not state how many were seen (Boll. Mus. Zool. Anat. Torino, XIV, No. 346, 1899, 3). No one has reported one at Panama

since. One was observed at the San Pedro fish markets in 1927. Two more were caught at Monterey in 1931 (J. B. Phillips, Calif. Fish and Game, Vol. 18, No. 1, p. 99).

The occasional recurrence of this fish indicates that somewhere in the ocean, beyond the ken of man, there is a stock that is maintaining the species.—*Richard S. Croker, California State Fisheries Laboratory, June 17, 1937.*

SNAKE EEL, *OPHICHTHUS TRISERIALIS*, TAKEN OFF SAN PEDRO

The waters off southern California constitute a transition area between colder waters of the temperate zones and warmer waters of the tropics. Many species of fish are common to this transition zone either as permanent residents or as seasonal visitors entering from the north or south, tarrying some months and returning to their former habitats. In addition to residents and annual visitors we occasionally find stragglers in our waters which have wandered well beyond their normal range.

Such a straggler was brought into the San Pedro fish markets on the morning of June 4, 1937. This fish, identified at the California State Fisheries Laboratory as a snake eel, *Ophichthus triserialis* (Kaup), was caught by a hand-line boat close to Los Angeles Harbor, probably off Point Firmin. The fish, still alive when brought in, caused much wonderment in the markets because of its snake-like appearance. There are many kinds of snake eels, all inhabitants of tropic seas. *O. triserialis* is commonly found from Lower California to the Galapagos Islands, but this capture off San Pedro apparently constitutes the northernmost record of its distribution. Our specimen was a female, 36 inches in length, with maturing eggs. That she would have spawned successfully in these waters seems doubtful.—*Frances N. Clark, California State Fisheries Laboratory, June 7, 1937.*

FURTHER NOTES ON THE JUMBO SQUID, *DOSIDICUS GIGAS*

Considerable surprise was evoked among fishermen and scientists when large numbers of the previously rare jumbo squid, *Dosidicus gigas*, appeared off the California coast during the summer of 1934. In waters where one had been a rarity, thousands appeared almost overnight (Frances N. Clark and J. B. Phillips, Calif. Fish and Game, Vol. 22, No. 2, pp. 143-144, 1936). Since 1934, the jumbo squid has ceased to be a novelty and indeed has become a pest.

This animal is an active, predaceous marine mollusk. It is one of the largest of our squids. Those that first appeared in southern California during 1934 and 1935 were 2 to 2½ feet in length and weighed about 5 pounds. Those caught in 1937 were much larger, averaging over 20 pounds; some weighed more than 30 pounds. At first they appeared only in the summer, but later they occurred throughout the year.

Considerable numbers of these squid were seen during the summers of 1934 and 1935. After a few trial landings it was found that there was no sale for them, hence no fishery was developed.

In 1936 they seemed to be even more abundant all the way from Monterey Bay to San Diego. It was in this year that they were first recognized as a nuisance by the fishermen. Albacore trollers were first bothered with them striking the jigs. Usually the squid pulled loose, but they invariably left some of their tender anatomy on the hooks to foul them. Those that were caught squirted slippery, insoluble ink on the decks much to the disgust of the fishermen. Rockfish set liners complained bitterly that the squid not only stole all the bait from their lines, but also damaged the fish that had been caught on the hooks.

The plague of jumbo squid has been worse in 1937. Set line, net and troll commercial fishermen are still bothered by them, and in addition sport fishermen have been harrassed all spring. No sooner does a pleasure boat start to fish than a horde of squid appears on the scene to crowd the game fish away and seize all the baits. When one is hooked, it proceeds to shower boat and fishermen with ink and water, and then delights in biting its captor with its parrot-like beak. Several fishermen have been seriously bitten this year. Although squid fishing is hilarious sport for a few minutes, it becomes too much of a good thing day after day. During 1937, the squid have been caught in large numbers at least as far south as the Coronado Islands.

To the best of our knowledge, no one has yet devised a way to make the jumbo squid palatable when prepared for the table. Consequently there has been no effort to capitalize on the present supply by developing a fishery for it. However, several fishermen have requested that the State pay a bounty on the squid in order to encourage their destruction.—*Richard S. Croker, California State Fisheries Laboratory, June 18, 1937.*

TWO NEW SARDINE BULLETINS

Two bulletins dealing with the California sardine fishery have recently been issued in the series of Fish Bulletins prepared by staff members of the California State Fisheries Laboratory. Both of these bulletins were written by Frances N. Clark in nontechnical language, although the first one concerns the rather complicated subject of fluctuating sizes of fish occurring in the commercial catch. This is Fish Bulletin 47, "Interseasonal and Intraseasonal Changes in Size of the California Sardine, *Sardinops caerulea*." The second bulletin, number 48, "Fishing Localities for the California Sardine, *Sardinops caerulea*, 1928-1936," is particularly clear and brief in treatment.

Essential in the study of the California sardine is an understanding of the two important fluctuations in size of fish that are characteristic of this fishery. The greater of the two size changes is a regular one occurring year after year within each season. It is a change from small fish in summer to medium sized fish in the fall and to large fish in the winter. The other change in size of fish is from one season to another. It occurs irregularly and is of lesser magnitude than the cycle of change within each season. Fish Bulletin 47 is a comprehensive account of the occurrence, characteristics and significance of these two types of size fluctuations occurring in the sardine catch at the various fishing ports of the State.

The bulletin summarizes the results of studies of fish size, inaugurated in 1919 and carried on continuously for the last sixteen years at

Monterey and San Pedro, with additional data for recent years at San Diego and San Francisco.

The change in fish sizes within each season is brought about, not by growth, but by size selective migrations into and out of each of the fishing localities of the State. The medium sized fish supplying the fall fishery represent three or four age classes of young fish, sexually immature or having spawned but once or twice. By contrast, the winter fishery draws from many more age classes, but chiefly from large sexually mature adults that have spawned several times. These two classes, fall and winter fish, behave so differently that they must be considered separately, almost as though we had two distinct sardine fisheries along our coast. Size studies of these two classes of fish in the different regions of the State have been the basis for the theories of migrations as worked out by the staff of the California State Fisheries Laboratory and now being checked by tagging experiments.

The irregular difference in fish sizes from one season to another is due to the success or partial failure of spawning, which affects the relative abundance of fish in each age class making up the population. Following an unusually successful spawning season the resulting superabundant age group has been recognized and traced in the catch of the following years for a period of eight or ten seasons. In recent years the dominance of the occasional superabundant age group has seemed to pass more quickly and the fact that such a group can now be traced but three or four years in the commercial catch is considered as one of the several danger signs indicating that our sardine population is suffering from excessive utilization. This bulletin, offered for publication in September, 1935, predicted that the heavy strain, especially upon the young fish of our fall fishery, if not abated, will result in serious depletion.

Fish Bulletin 48 is a concise general discussion of sardine fishing localities, comparing the areas throughout the entire State and considering their relationship to depth of ocean waters and distances from shore and from points of delivery.

Detailed observations of the sardine fishery and sampling of the catch have been conducted without interruption since 1919. The first ten years, from 1919 to 1929, covered the period of development of the canning industry and rapid expansion of the ocean areas. Detailed accounts of change in fishing localities during this period have been published previously so that Bulletin 48 deals chiefly with the last eight fishing seasons, 1928-29 to 1935-36. This later period has been a time of comparative stability so far as fishing areas are concerned, except for the development of new grounds off San Francisco with the establishment of canning plants in the Bay Region.

The discussion of catch locality in relation to ocean depths concludes that in the Monterey fishery practically no catches were made except over the continental shelf inside the 100-fathom contour line. In southern California the fishing appears to concentrate over the steep slope of the continental shelf, between the 100- and 500-fathom contour intervals with very few catches made in waters deeper than 500 fathoms.

Graphic charts summarize the data relating locality of catch to distance from the shore line so that the reader may see at a glance the

percentage of catches falling inside each one-mile distance interval from shore. Practically all catches are less than 18 miles from shore and the proportion occurring inside the 3-mile State boundary line (not always 3 miles from shore) is 75 per cent for the Monterey region and 38 per cent for the San Pedro fishery.

An outstanding feature of this bulletin is the presentation of three maps of the State's coastline to illustrate features of the sardine fishery. The first map shows ocean depths in 100-fathom intervals, upon which have been superimposed dots, each of which represents the point at which a sardine catch was made. The reader may determine for himself the relationship between ocean depth and locality of catch and see the concentration of catches occurring on the continental shelf or along the steep seaward face of the shelf.

The second map is of special interest as it pictures the serially numbered blocks into which the ocean waters off this State have been divided, and each block carries a symbol representing the number of tons of fish caught from the block. This map is thus a graphic yield table for each portion of the ocean from Point Arena to the southern boundary of the State for the 1935-1936 sardine fishing season. It is a record of the crop harvested from each field and is a step toward the goal of true conservation management under which each area is administered upon the basis of sustained annual yield, thus affording the fullest possible continuous utilization of the area.

The third map also represents catch localities as dots but in this case they are related to the 3-mile State boundary line. With the absence of depth contours the concentration of catches near certain headlands is more clearly illustrated.—*W. L. Scofield, California State Fisheries Laboratory, Terminal Island, California, June, 1937.*

GRAPHIC HISTORY OF THE COMMERCIAL FISH CATCH

Answering the call of the fisheries administrators, we present the Division's Fish Bulletin number 49, as a handy reference book for those concerned with the commercial fish catch. There has been gathered into one "catch bulletin" a set of graphic charts and a short history of each of the commercial species, whether it ranks high in importance or is merely listed occasionally in the tables of landings. For comparative purposes the graphs will at a glance answer many pertinent questions. We call particular attention to the list of references which will supply a valuable key for those who wish to pursue the subject of any one species in greater detail than the author felt necessary to give.

Fish Bulletin number 49 is the fifth in a series of catch bulletins originating at the California State Fisheries Laboratory, the fruits of the statistical system (previous ones were Fish Bulletins 15, 20, 30 and 44). Its title, "The Commercial Fish Catch of California for the Year 1935," would infer that it deals only with statistics for 1935. The detailed tables are for that year alone, but the text covers the statistics from 1916 to date. The data used in its compilation were gathered and compiled through the combined efforts of the staff of the Bureau of Commercial Fisheries. The articles, with the exception of one, are contributions of the staff members of this bureau.

The authors were permitted considerable license and their enthusiasm has lifted this bulletin out of the plane of a mere textbook. Their

efforts to add a dash of color and express the individuality of the species with which they dealt has made interesting reading material out of a volume of facts.

To round out its usefulness, the bulletin contains special articles on value of the catch, canned products, oil and meal production, fish livers, the commercial fishing fleet and the fishermen.—*Geraldine Conner, California State Fisheries Laboratory, May, 1937.*

MARINE FISHES OF SOUTHERN CALIFORNIA

A notable contribution to the study of California fishes was published by the University of California Press late in 1936. It is a 209-page book, entitled "Marine Fishes of Southern California," by Percy Spencer Barnhart, ichthyologist at Scripps Institution of Oceanography, La Jolla. This book contains brief descriptions of all native and introduced species of marine fishes known to occur between Pt. Conception and San Diego. Capable black and white drawings of 290 species of fish, made by the author, illustrate the book. These illustrations, which are more than mere outline sketches, comprise one of the finest groups of fish drawings we have seen. The book contains several keys to families and genera, and has a glossary, bibliography, index of common names and index of scientific names. No serious fisherman or student of fishes can afford to be without a copy.—*Richard S. Croker, Editor, "California Fish and Game," June, 1937.*

MARINE GAME FISHES OF THE PACIFIC COAST

Early in 1937 a noteworthy handbook of fishes made its appearance, as a contribution of the Santa Barbara Museum of Natural History. Lionel A. Walford, who wrote it, and the University of California Press, who published it, can well be proud of "Marine Game Fishes of the Pacific Coast from Alaska to the Equator." Dr. Walford, who is now with the United States Bureau of Fisheries and was for a number of years on the research staff of the California Division of Fish and Game, has studied Pacific Coast fishes at first hand and speaks with authority.

The book, containing 205 pages and 69 plates, concerns itself with game fishes only, although it has a key to all the families of fishes occurring on the Pacific Coast. All the game fishes are discussed in more or less detail, some at considerable length, with scientific descriptions, life history notes and angling instructions. The style of writing is pleasing and should be acceptable to scientists as well as to sportsmen for whom the book is primarily intended.

The text is accompanied by a remarkable collection of illustrations. There are 60 black and white photographs and wash drawings of fish as well as many outline sketches, not to mention a number of illustrations of fishing gear and baits. However, the color illustrations of fish, 57 in number, are so outstanding that they overshadow the black and white. The color paintings and wash drawings are by Link Malmquist. The natural color photography is by Ralph Emerson, who also made many of the black and white photographs. A number of photographs were loaned by the California State Fisheries Laboratory.—*Richard S. Croker, Editor, "California Fish and Game," June, 1937.*

REPORTS

STATEMENT OF REVENUE

For the Period July 1, 1936, to March 31, 1937, of the Eighty-eighth Fiscal Year

Revenue for Fish and Game Preservation Fund:		
Current Year:		
License Sales:		
Angling licenses, 1936	$423,690 50	
Angling licenses, 1937	17,675 00	
Commercial hunting club licenses, 1936-1937	750 00	
Commercial hunting club operators' licenses, 1936-1937	145 00	
Deer tags, 1936	126,852 00	
Fish breeders' licenses, 1936	30 00	
Fish breeders' licenses, 1937	305 00	
Fish importers' licenses, 1936	5 00	
Fish importers' licenses, 1937	70 00	
Fish packers' and wholesale shellfish dealers' licenses, 1936-1937	1,100 00	
Fishing party vessel permit, 1937	41 00	
Fishing party vessel permit, 1936	59 00	
Game breeders' licenses, 1936	120 00	
Game breeders' licenses, 1937	817 50	
Hunting licenses, 1934-1935	661 16	
Hunting licenses, 1935-1936	19,851 00	
Hunting licenses, 1936-1937	238,085 50	
Kelp licenses, 1936	10 00	
Market fishermen's licenses, 1936-1937	41,760 00	
Market fishermen's licenses, 1937-1938	620 00	
Trapping licenses, 1936-1937	1,867 00	
Total license sales		$874,514 66
Other income:		
Court fines	$52,457 29	
Fish packers' tax	252,413 85	
Fish tag sales	1,986 04	
Game tag sales	188 94	
Importers' contributions	230 00	
Interest on bank balances	5,201 51	
Kelp tax	158 35	
Lease of kelp beds	1,309 20	
Miscellaneous sales	4,495 97	
Publication sales	222 88	
Salmon tax, Chap. 1015-35	16,888 71	
Total other income		$335,552 74
Grand total		$1,210,067 40

STATEMENT OF EXPENDITURES

For the Period July 1, 1936, to March 31, 1937, of the Eighty-eighth Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Operating Expenditures 88th Fiscal Year:					
Administration:					
Executive	$3,749 94				$3,749 94
General office	4,290 00	$1,120 02	$601 30	$97 47	6,108 79
Printing general		2,254 80			2,254 80
Printing, fish and game magazine		922 07			922 07
Automobiles		257 28	188 14		445 42
Traveling			1,713 18		1,713 18
Postage			3,443 62		3,443 62
Telephone and telegraph			2,766 76		2,766 76
Freight, cartage and express			601 66		601 66
Rent			8,047 36		8,047 36
Accident and death claims			2,827 20		2,827 20
Department administration pro rata	8,629 99		190 65		8,820 64
Librarian	1,200 00	152 50	44 46	114 57	1,511 53
Legal			3,252 08		3,252 08
Premiums on bonds			35 00		35 00
Publicity			1,090 60		1,090 60
Pro rata General Fund expense, Chap. 923-33			1,561 28		1,561 28
Sales tax on sales			—1 05		—1 05
Total Administration	$17,869 93	$4,706 67	$26,362 24	$212 04	$49,150 88
Patrol and Law Enforcement:					
Chief and assistants	$11,098 06				$11,098 06
General office	3,711 51	$51 58	$49 22	$68 17	3,880 48
Automobiles		25,653 53	9,700 59	20,153 82	55,507 94
Traveling			38,204 79		38,204 79
Postage			594 05		594 05
Telephone and telegraph			1,528 31		1,528 31
Freight, cartage and express			1 93		1 93
Rent			616 48		616 48
Captains and wardens	155,434 05	568 15	837 15	115 41	156,954 76
Launches	6,219 10	7,231 72	5,049 83	460 91	18,961 56
Premiums on bonds			20 98		20 98
Temporary help	490 81				490 81
Assistant fish and game wardens, seasonal	20,269 56				20,269 56
Heat, light, water and power			5 47		5 47
Total Patrol and Law Enforcement	$197,223 09	$33,504 98	$56,608 80	$20,798 31	$308,135 18
Commercial fisheries:					
Chief and assistant	$7,830 00				$7,830 00
General office	6,434 11	$43 77	$19 49	$174 00	6,671 37
Automobiles		490 39	143 78	623 15	1,257 32
Travel			5,390 42		5,390 42
Telephone and telegraph			578 23		578 23
Freight, cartage and express			127 85		127 85
Rent			121 51		121 51
Heat, light, water and power			444 46		444 46
Research (oyster)	1,710 00	33 11			1,743 11
Laboratory	22,250 42	1,812 70	1,374 01	1,032 72	26,469 85
Fish tags		177 98			177 98
Cooperative research		29 50	750 00		779 50
Statistics		397 21	1,585 54	168 62	2,151 37
Temporary help	687 09				687 09
Terminal Island grounds	750 00	23 73	4 68	7 67	786 08
Fish cannery auditing			2,135 00		2,135 00
Total Commercial Fisheries	$39,661 62	$3,008 39	$12,674 97	$2,006 16	$57,351 14
Fish Conservation:					
Chief and assistants	$5,275 81	$4 53			$5,280 34
General office	3,698 72	11 33	$11 55	$3 03	3,724 63
Automobiles		6,757 84	2,627 66	9 19	9,394 69
Traveling			6,745 42		6,745 42
Postage			134 34		134 34
Telephone and telegraph			794 42		794 42
Freight, cartage and express			381 66		381 66
Rent			1,256 49		1,256 49
Heat, light, water and power			1,530 24		1,530 24
Research		5 06	227 67	10 17	242 90
Fish planting		599 69	1,729 50	14 30	2,343 49
Hatcheries	82,047 08	37,090 90	736 92	724 97	120,599 87
Fish cars	1,350 00	1 44	962 64		2,314 08
Blue printing			2 58		2 58
Cooperative research	1,753 23	154 15	169 05	21 33	2,097 76
Statistical	1,123 71	77	628 37		1,952 85

STATEMENT OF EXPENDITURES

For the Period July 1, 1936, to March 31, 1937, of the Eighty-eighth Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Temporary help	$700 19				$700 19
Special field	10,230 00	$23 13	$5 21		10,258 34
Fish rescue	1,440 00	41	25 50		1,465 91
Assistant fish and game wardens, seasonal	19,615 29				19,615 29
Total Fish Conservation	$127,234 03	$44,649 25	$18,169 22	$782 99	$190,835 49
Hydraulics:					
Chief and assistant	$5,887 96				$5,887 96
General office	1,440 00	$49 38	$5 86	$22 36	1,517 60
Automobiles		290 54	70 70	10 97	372 21
Traveling			1,803 29		1,803 29
Telephone and telegraph			1 20		1 20
Blue printing			26 76		26 76
Temporary help	84 64				84 64
Total Hydraulics	$7,412 60	$339 92	$1,907 81	$33 33	$9,693 66
Game Conservation:					
Chief and assistants	$11,478 30				$11,478 30
General office	3,060 00	$77 14	$26 25	$28 21	3,191 60
Automobiles		1,666 65	580 65	1,889 78	4,137 08
Traveling			2,690 14		2,690 14
Telephone and telegraph			332 78		332 78
Freight, cartage and express			92 14		92 14
Heat, light, water and power			2,160 80		2,160 80
Maintenance of game farms	8,654 97	12,044 97	224 67	1,973 81	22,898 42
Statistics	473 87	1 22	824 75		1,299 84
Temporary help	5,150 68				5,150 68
Maintenance of game refuges	3,758 00	948 29	125 50	11 64	4,843 43
Total Game Conservation	$32,575 82	$14,738 27	$7,057 68	$3,903 44	$58,275 21
Licenses:					
General office	$11,055 00	$808 53	$147 22	$2 16	$12,012 91
Printing licenses and applications		2,437 77			2,437 77
Traveling			257 18		257 18
Postage			884 08		884 08
Freight, cartage and express			43 39		43 39
Premiums on bonds			1,051 17		1,051 17
Identification license buttons		9,617 86			9,617 86
License commissions			43,106 19		43,106 19
Total licenses	$11,055 00	$12,864 16	$45,489 23	$2 16	$69,410 55
Special Item:					
State Fair and other exhibits (Payable from Support, Chap. 341-35 or E. O. for Support)	$40 00	$117 37	$1,200 00		$1,357 37
Total, 88th Fiscal Year:					
Expense paid from Support appropriations	$433,072 09	$113,929 01	$169,469 95	$27,738 43	$744,209 48
Prior year, 87th fiscal year, for Support					13,051 49
Total, 87th and 88th fiscal years, for Support					$757,260 97
Special Items:					
Predatory Animal Control:					
88th fiscal year:					
Chief and assistants	$2,725 00				$2,725 00
General office	668 38			$25 00	693 38
Automobiles		$2,299 69	$647 00	13 12	2,959 81
Traveling			2,039 99		2,039 99
Predatory animal control	13,030 50	1,113 56	4,502 56		18,646 62
Predatory animal hunters and trappers, seasonal	4,500 00				4,500 00
Total, 88th fiscal year	$20,923 88	$3,413 25	$7,189 55	$38 12	$31,564 80
Prior year, 87th fiscal year, special item—Predatory animal control					$68 25
Total Predatory Animal Control, 87th and 88th fiscal years					$31,633 05
Total operating expenditures, 87th and 88th fiscal years					$788,894 02

STATEMENT OF EXPENDITURES

For the Period July 1, 1936, to March 31, 1937, of the Eighty-eighth Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Expenditures for additions and betterments:					
Permanent improvements:					
Purchase of game refuges and public shooting grounds and construction, improvements and equipment, Chap. 341-35	$13,234 93	$18,898 59	$7,666 75	$16,934 04	$56,734 31
Prior year, 87th fiscal year:					
Construction, improvements and equipment and purchase of game refuges and public shooting grounds, Chap. 341-35, all objects					$1,908 47
Total permanent improvements, 87th and 88th fiscal years					$58,642 78
Contributions to Employees' Retirement System, 88th fiscal year					12,193 68
Total current biennium					$859,730 48
Prior biennium appropriations:					
Operating expenditures					
85th fiscal year:					
Special Item:					
Claim of Chief Accounting Officer, Department of Finance, Chap. 991-33				**—71 00**	
Total 85th fiscal year					**—71 00**
88th fiscal year:					
Special Item:					
Construction Russian River Jetties, Chap. 989-33			$167 50		
California Code Commission, Chap. 645-33			1 50		
Total operating expenditures, 88th fiscal year					$169 00
Total prior biennium appropriations					98 00
Grand total					$859,828 48

FISH CASES

January, February, March, 1937

Offense	Number arrests	Fines imposed	Jail sentences (days)
Abalones; closed season; undersize; possession sliced in closed season	54	$909 00	297½
Angling; no license	21	212 00	2
Bass, sea; undersize	1		
Bass, striped; overlimit; possession for sale	5	250 00	
Clams; offering for transportation; overlimit; undersize; selling overlimit; out of shell	46	1,787 50	115
Commercial fishing; no license	12	185 00	
Crabs; closed season; possession female; undersize	12	170 00	25
Fishing; closed area, season; false statement in procuring license; failure to produce license on demand; use, possession prohibited gear	32	810 00	12½
Lobsters; oversize; undersize	5	30 00	10
Night fishing	2	50 00	
Operating smokehouse; no packer's license	1		
Pollution	13	825 00	
Salmon; gaffing; transporting	2	60 00	
Trout; closed district, season; overlimit	8	55 00	10
Tuna; selling underweight	7	300 00	
Totals	221	$5,643 50	472

SEIZURES OF FISH AND GAME

January, February, March, 1937

Game:		Fish:	
Deer	13	Abalone	585
Deer hides	25	Abalone, pounds	2,856
Deer meat, pounds	1,001	Bass, sea, barrels	60
Doves	7	Bass, striped	28
Ducks	1,577	Bass, striped, pounds	200
Eagle	1	Blue cod, pounds	4
Goose	1	Clams	1,461
Mudhens	22	Cockles, pounds	225
Non-game birds	132	Crabs	44
Pheasants	19	Lobsters	298
Quail	206	Lobsters, pounds	110
Rabbits	11	Lobster pots	3
Squirrels	2	Perch	43
Swan	2	Salmon, pounds	150
		Set line	1
		Skipjack tuna, pounds	873
		Trout	503
		Trout, pounds	150
		Yellowfin tuna, pounds	29,393

GAME CASES

January, February, March, 1937

Offense	Number arrests	Fines imposed	Jail sentences (days)
Bird nets; possession	1	$25 00	
Concealed weapon carried	1	25 00	
Deer; killing, possession doe, spotted fawn, spike buck; closed season, district; dogs running deer; no tags; failure to fill out tag	92	3,121 00	1,703
Disturbing traps	2	20 00	
Doves; closed season	2	50 00	
Ducks; closed season; overlimit	74	4,377 50	1,115
Eagle; possession	1	100 00	
Firearms in refuge	7	35 00	
Geese; closed season	2	100 00	
Grouse; possession	1	10 00	
Hunting; closed area, season; no license; in refuge; false statement in procuring license; failure to produce license on demand; alien purchasing citizen's license	78	1,296 50	40½
Illegal shooting	27	655 00	10
Mudhens; closed season	5	70 00	
Night hunting	2	100 00	
Non-game birds; killing, possession, pursuit of	31	675 00	10
Pheasants; closed season; overlimit	10	150 00	10
Pigeons; closed season	1		
Protected birds; possession	1	5 00	
Quail; overlimit; closed season; failure to tag domesticated	4	63 56	50
Rabbits; closed season	3	150 00	
Rail; killing	2		
Swan; possession, killing	6	200 00	
Trapping; no license	1	2 00	
Tree squirrel; possession	4	100 00	
Trespass	13	132 50	
Totals	371	$11,463 06	2,938½

FRESH FISH IMPORTATIONS* FROM FOREIGN COUNTRIES FOR JANUARY, FEBRUARY AND MARCH, 1937

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	Landed in Region 70, Los Angeles	Landed in Region 80, San Diego	Total pounds
Barracuda	125,306	108,928	234,234
Cabrilla	21,366	66,608	87,974
Corbina, Mexican	48,450	------	48,450
Grouper	1,930	36,055	37,985
Halibut, California	11,407	129,514	140,921
Mackerel, Spanish	4,311	2,889	7,200
Perch	------	287	287
Rock Bass	9,192	1,536	10,728
Rockfish	------	72,183	72,183
Sea-bass, Black	58,972	37,318	96,290
Sea-bass, Totuava	242,711	19,640	262,351
Sea-bass, White	303	6,266	6,569
Shark	831	223	1,054
Sheepshead	745	1,759	2,504
Smelt	------	793	793
Tuna, Albacore	136,377	------	136,377
Tuna, Bonito	10,233	65,247	75,480
Tuna, Oriental	82,010	------	82,010
Tuna, Skipjack	1,782,499	641,696	2,424,195
Tuna, Yellowfin	2,460,244	12,781,122	15,241,366
Whitefish	1,736	3,702	5,438
Yellowtail	34,884	414,130	449,014
Crustacean:			
Lobster, Spiny	1,530	629,314	630,844
Prawn	1,125	------	1,125
Shrimp	9,569	------	9,569
Total pounds	5,045,731	15,019,210	20,064,941

* These importations are included in tables of landings. They include fish caught by California boats in foreign waters as well as frozen fish imported for canning in California plants.

FRESH FISH IMPORTATIONS BY POINT OF ORIGIN* FOR JANUARY, FEBRUARY AND MARCH, 1937

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	Gulf of California	West coast Lower California	International waters south U.S. boundary (definite origin unknown)	Mexican Mainland, Central and South America	Japan	Total pound
Barracuda		234,234				234,234
Cabrilla	9,740	78,234				87,974
Corbina, Mexican	48,450					48,450
Grouper	1,185	36,800				37,985
Halibut, California		140,921				140,921
Mackerel, Spanish		7,200				7,200
Perch		287				287
Rock Bass		10,728				10,728
Rockfish		72,183				72,183
Sea-bass, Black	1,234	95,056				96,290
Sea-bass, Totuava	262,351					262,351
Sea-bass, White		6,569				6,569
Shark		1,054				1,054
Sheepshead		2,504				2,504
Smelt		793				793
Tuna, Albacore					136,377	136,377
Tuna, Bonito		75,395	85			75,480
Tuna, Oriental					82,010	82,010
Tuna, Skipjack		107,760	842,128	276,283	1,198,024	2,424,195
Tuna, Yellowfin		147,786	9,620,619	5,472,961		15,241,366
Whitefish		5,438				5,438
Yellowtail		408,059	40,955			449,014
Crustacean:						
Lobster, Spiny		630,844				630,844
Prawu	1,125					1,125
Shrimp	9,569					9,569
Total pounds	333,654	2,061,845	10,503,787	5,749,244	1,416,411	20,064,941

* These importations are included in tables of landings. They include fish caught by California boats in foreign waters as well as frozen fish imported for canning in California plants.

CALIFORNIA FRESH FISH LANDINGS* FOR JANUARY, FEBRUARY AND MARCH, 1937

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	Region 10, Del Norte	Region 20, Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds
Anchovy					14,480		6,738		21,218
Barracuda						42	139,435	114,598	254,075
Cabezone				450	431	18			899
Cabrilla							21,366	66,608	87,974
Carp			17,237						17,237
Catfish			40,040						40,040
Corbina, Mexican							48,450		48,450
Cultus, Pacific	2,532	133,549		83,937	30,800	357	307		251,482
Eel				4					4
Flounder, Starry		1,945		294,735	4,268				300,948
Grouper							1,930	36,137	38,067
Hake				12,516			2,332		14,848
Halibut, California				3,717	10,595	47,978	152,833	195,316	410,439
Halibut, Northern	51	1,024		1,090					2,165
Hardhead			17,207						17,207
Herring, Pacific		6,495		534,469	690	14		3,012	544,680
Kingfish					46,109		184,624	79	230,812
Mackerel, Horse					526		1,183,723	18,480	1,202,729
Mackerel, Pacific				225	443,657	3,396	3,304,701	312,639	4,064,618
Mackerel, Spanish							4,311	2,889	7,200
Mullet							465		465
Perch	78	1,481		38,067	8,826	1,329	15,374	287	65,442
Pike			246						246
Pompano, California					15		1,566		1,581
Rock Bass						1,509	17,546	9,839	28,894
Rockfish	7,101	20,233		201,432	580,276	136,119	149,257	119,565	1,213,983
Sablefish	56	16,409		3,216	819		84,752		105,252
Salmon			40,870		27,334		9		68,213
Sand Dab				121,142	309		3,215	13	124,679
Sardine			12,476,500	16,042,715	88,308,135		231,009,184	9,138,021	356,974,555
Sculpin						13	28,826	4,307	33,146
Sea-bass, Black					36	356	59,533	37,973	97,898
Sea-bass, Totuava							242,711	19,640	262,351
Sea-bass, White					528	10,344	9,071	13,628	33,571
Shad			10,941		18				10,962
Shark				178,918	43,099	15,342	39,795	16,520	293,674
Sheepshead						9,669	19,097	2,796	31,562
Skate				108,488	4,561	11,849	7,244	786	132,928
Smelt		5,268		100,926	5,770	1,437	53,612	2,074	169,087
Sole	30			1,853,421	38,361	49,259	1,045	12	1,942,128
Split-tail			7,444						7,444
Sucker			3,897						3,897
Tomcod				848					848

Tuna, Albacore							136,377		136,377
Tuna, Bonito					206	22	145,149	215,402	360,779
Tuna, Oriental							82,010		82,010
Tuna, Skipjack							1,782,499	641,696	2,424,195
Tuna, Yellowfin							2,460,244	12,781,122	15,241,366
Turbot				13,372	2,454				15,826
Whitebait	15,904	3,321		2,837	216				22,278
Whitefish						866	7,035	6,706	14,607
Yellowtail						11	41,281	415,640	456,932
Miscellaneous fish		2,465	2	37,054	168	98	1,680		41,467
Crustacean:									
Crab	3,924	38,352		438,584	1,700	44			482,604
Crab, Rock				50			1,116		1,166
Lobster, Spiny						35,136	43,436	632,304	710,876
Prawn					892		1,125		2,017
Shrimp				156,700			9,583		166,283
Mollusk:									
Abalone					39,850	135,401			175,251
Clam, Cockle				141			7,824		7,965
Clam, Gaper		480		368					848
Clam, Pismo					4,225	41,040			45,265
Clam, Soft-shell				20,910					20,910
Clam, Washington		6,975		710					7,685
Mussel					1,490				1,490
Octopus		291		589	8,062	158	67		9,167
Oyster, Eastern				95,850					95,850
Oyster, Japanese			30,132	85,795					115,927
Oyster, Native				18,793		6			18,799
Squid				325	18,880		31,285		50,490
Total pounds	29,676	238,288	12,644,519	20,452,394	89,647,786	501,813	241,543,763	24,808,089	389,866,328

* Importations of fresh fish from foreign countries included. See foreign importation tables.

o

16325 9-37 2700

BUREAU OF PATROL

E. L. MACAULAY, Chief of Patrol — San Francisco

CENTRAL DISTRICT (Headquarters, Sacramento)

S. H. Lyons, Inspector in Charge — Sacramento
L. E. Mercer, Warden, Flying Squad — Sacramento
Ed Hughes, Assistant Warden, Flying Squad — Sacramento
Chas. Sibeck, Warden, Launch "Rainbow" — Sacramento

Northern Division

Jos. H. Sanders, Captain in Charge — Sacramento
A. H. Willard, Captain — Nevada City
————, Sergeant — Redding
A. A. Jordan, Warden, Modoc County — Alturas
Brice Hammack, Warden, Siskiyou County — Yreka
Fred R. Starr, Warden, Siskiyou County — Dorris
C. L. Gourley, Warden, Trinity County — Weaverville
Earl Caldwell, Warden, Shasta County — Montgomery Creek
Chas. Love, Warden, Shasta County — Redding
C. O. Fisher, Warden, Lassen County — Susanville
W. C. Blewett, Warden, Plumas County — Quincy
R. W. Anderson, Warden, Tehama County — Red Bluff
E. C. Vail, Warden, Glenn County — Willows
E. O. Wraith, Warden, Butte County — Chico
A. Granstrom, Warden, Sierra County — Downieville
Earl Hiscox, Warden, Nevada County — Nevada City
R. A. Timmin, Warden, Yuba County — Challenge
L. W. Dinsdale, Warden, Sutter County — Yuba City
Taylor London, Warden, Colusa County — Colusa
R. L. Sinkey, Warden, Yolo County — Woodland
W. J. Black, Warden, Solano County — Suisun
H. S. Vary, Warden, Sacramento County — Sacramento
Nelson Poole, Warden, Placer County — Auburn
Albert Sears, Warden, El Dorado County — Placerville

Southern Division

S. R. Gilloon, Captain in Charge — Fresno
John O'Connell, Captain — Stockton
————, Sergeant — Bakersfield
Wm. Hoppe, Warden, San Joaquin County — Lodi
R. J. Little, Warden, Amador County — Jackson
J. W. Thornburg, Warden, Calaveras County — Angels Camp
F. F. Johnston, Warden, Tuolumne County — Sonora
Geo. Magladry, Warden, Stanislaus County — Modesto
M. S. Clark, Warden, Merced County — Merced
Ray Ellis, Warden, Kings County — Hanford
Clarence Brown, Warden, Mariposa County — Mariposa
H. E. Black, Warden, Madera County — Madera
Paul Kehrer, Warden, Fresno County — Fresno
F. A. Bullard, Warden, Fresno County — Reedley
R. J. Bullard, Warden, Tulare County — Porterville
W. I. Long, Warden, Tulare County — Visalia
C. S. Donham, Warden, Merced County — Gustine
Lester Arnold, Warden, Kern County — Bakersfield
Roswell Welch, Warden, Kern County — Kernville

COAST DISTRICT (Headquarters, San Francisco)

K. P. Allred, Inspector in Charge — San Francisco
Scott Feland, Warden, Flying Squad — San Francisco
Eugene Durney, Assistant Warden, Flying Squad — San Francisco

Northern Division

W. J. Harp, Captain in Charge — Ukiah
J. D. Dondero, Captain — Eureka
Henry Lencioni, Captain — Santa Rosa
John Hurley, Warden, Humboldt County — Eureka
W. F. Kaliher, Warden, Humboldt County — Fortuna
Ray Diamond, Warden, Mendocino County — Willits

CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION."

VOLUME 23 SAN FRANCISCO, OCTOBER, 1937 Number 4

TABLE OF CONTENTS

CALIFORNIA FISH AND GAME is a publication devoted to the conservation of wild-life. It is published quarterly by the California Division of Fish and Game. All material for publication should be sent to Richard S. Croker, editor, California State Fisheries Laboratory, Terminal Island, California.

49659

WATER POLLUTION PROBLEMS IN CALIFORNIA[1]

By PAUL A. SHAW and C. L. TOWERS
California Division of Fish and Game

Extensive reports on water pollution may be found in the current literature of various federal, state, conservation and other agencies. Many are scientific, covering the deleterious effect of pollutants on fish life, details of stream surveys, purification and treatment methods, etc. Other papers, particularly those from the National Resources Committee on Water Pollution, have dealt with administrative, economic, educational, cooperative and enforcement aspects of this nationwide hazard, looking toward a workable program of control.

Considering the excellent references available, it would appear unwarranted to present a technical discussion and we will therefore confine our remarks to the law which guides our activities, then attempt to portray, more or less pictorially, a few of the detrimental conditions we face from day to day in California. We do this with the thought of stimulating an increased demand on the part of the public and further endeavor on the part of industries and municipalities toward maintaining clean waterways. Public demand for less contamination of our recreational resources is becoming more insistent, and activity of private interests in regulating their own industries is more evident. It is believed the time will come when former pollutors will take equal pride in backyard (public water) cleanliness and frontyard (national advertising) attractiveness.

Surveys of the National Resources Committee indicate that states having strict pollution statutes accomplish little more than states with ineffective laws. Notwithstanding this fact, we feel that vigorous enforcement would reveal effective differences in state laws, for, in the final analysis, any action that *can* be taken is dependent on the existing law. Whether or not action *is* taken, to the extent of the existing law, will depend in a large measure on the attitude of the public, particularly those who utilize our natural resources, and on their support of adequate agencies to carry out its provisions.

Experience in California indicates definitely that fair but firm law enforcement accelerates the rate at which improvement is effected. While many instances of remedial action have resulted from educational work, the same effort has been obviously more effective when backed by statute. Education may be the standard on which humanity is built, but we should remember that even a baby is chastised for its misdemeanors and that ofttimes a spanking (law enforcement) is the best education when the principals fail to accept the right road through suggestion or cooperation.

---

[1] Submitted for publication, August, 1937.

Section 481 of the California Fish and Game Code, which is the basis of activities by our pollution detail, reads as follows:

> "It is unlawful to deposit in, permit to pass into, or place where it can pass into the waters of this State, any petroleum, acid, coal or oil tar, lamp black, aniline, asphalt, bitumen, or residuary product of petroleum, or carbonaceous material, or substance, or any refuse, liquid or solid, from any refinery, gas house, tannery, distillery, chemical works, mill or factory of any kind, or any sawdust, shavings, slabs, edgings, or any factory refuse, or any lime, any occulus indicus, or any slag, or any substance or material deleterious to fish, plant life, or bird life."

It will be noted that this law specifically prohibits a large number of solids, liquids and sources; further, the discharge of liquid or solid refuse from a mill or factory of any kind is prohibited; and finally, the statute covers any substance or material deleterious to fish, plant life, or bird life, thus providing in its entirety an extremely

FIG. 45. Field kit used for chemical analysis.

broad law through which pollutants of a visible nature are largely restricted and by which pollutants of an invisible nature may be controlled should investigation reveal their character as harmful.

It should be obvious that considerable judgment must be exercised in enforcing the provisions of such an inclusive statute, and so, while the statute forms the nucleus of the enforcement program, the work is specialized to the extent that correlated programs of scientific investigation, cooperation and education are essential to successful accomplishment.

We have solicited and received remarkable cooperation from agencies such as the U. S. War Department through their district engineers, the U. S. Customs, the U. S. Coast Guard, State and local health departments and others who are charged with the enforcement of similar or related laws. Further cooperation through prosecuting agencies, judges, sportsmen's organizations, chambers of commerce,

representatives of certain industrial groups and many individuals has materially aided in our program. Throughout the work, field, laboratory and experimental investigations are conducted to determine existing conditions and to serve as evidence and justification for action. Figure 45 shows a type of field kit used for stream surveys and chemical analysis. Figure 46 shows representatives of the State and the U. S. Coast Guard collecting a sample containing oil.

In general, pollutants of a visible type are easily traced to their source, their effects on aquatic environment are well established, and the necessary procedure is largely a matter of law enforcement. On the other hand, pollutants that we here classify as invisible may take their toll of fish life before recognition of their presence, resulting in aquatic catastrophes or barren water areas; or, if the source is known, the determination of their deleterious character may involve complete analysis and extensive field surveys to establish a sound basis for enforcement.

FIG. 46. Coast Guard and Division of Fish and Game officers collecting oil samples.

However, it should not be concluded that detailed investigation is limited to invisible pollutants. To illustrate this point there was recently reported a serious degree of oil pollution at a recreational beach on a Sunday morning when some 60,000 people anticipated a pleasant holiday. The condition they found is well illustrated by figure 47. One of the group was righteously wrought up to the extent of paying a $28 long distance telephone call to report the situation to Washington. While there was no apparent source of the contamination, investigation by one of the pollution detail in cooperation with the Coast Guard, covering data on tides, wind, drifts, movement of ships, etc., revealed the probable source as being a vessel that had fueled in a nearby harbor on the preceding night. The ship had cleared port but instructions were wired ahead and the vessel was boarded by the Coast Guard for the purpose of securing an oil sample. Laboratory analysis of this sample compared with an analysis of oil on the water and beach proved their identity, the technical data thus serving as definite prosecuting evi-

dence. The realization that no effort will be spared in tracing down negligent crews and others who thoughtlessly despoil our natural resources, is having a very salutary effect in decreased carelessness and consequent aquatic improvement.

Educating potential pollutors in the necessity for extreme care in handling products capable of causing damage is well illustrated by the recent and more rigid instructions issued by shipping concerns on oil

FIG. 47. Typical oil covered beach.

pollution. The following quotation is the translation of instructions issued by a Japanese shipping company:

"January 8, 1937

"To Captain and Chief Engineer:

Subject: Request for caution against allowing oil to flow within Los Angeles harbor.

It is needless to state that the authorities in any harbor are especially strict in regard to the handling of oil. Particularly is the case true in respect to the prevention of the leakage and flow of oil.

Recently the port authorities of the Los Angeles harbor in North America had added stringent requirements to the extent that several of our Japanese vessels have been cited for negligence and assessed huge fines.

1. Scupper pipes should be closed with wooden stoppers and further made fast by applying hard cement prior to entering port.

2. In the event that flow and leakage should continue despite every precaution, all effort should be made to remove the oil from the surface of the water and every measure taken in order that the port authorities can be satisfied of the steps taken to abide by the regulation.

3. All remnant liquid within the bilge and oil tanks should be emptied after leaving, 50 miles beyond the harbor. A penalty is liable should such offense occur within 50 miles of the harbor.

Further precaution is requested on all other regulations as well.

Shipping Company
Kobe, Japan"

Major oil companies have issued equally rigid regulations including instructions that bilge or ballast should be emptied 50 to 100 miles from shore. The following quotation is from a notice released by the District Engineer, U. S. War Department, on July 10, 1937:

> "The navigable jurisdiction of the U. S. extends over the coastal waters to such distance seaward as may be necessary to give full effect to the laws for the protection and preservation of the navigable waters of the United States.
>
> "This distance is not controlled by any special limits of three or twelve miles, which may have been set up for other special purposes, but is an assertion of the right of the United States to prohibit the doing of anything which tends to affect the navigable waters contrary to existing law."

FIG. 48. Loading spill resulting from careless pumping.

The thought expressed in the above paragraphs is similar to the intent of Section 481 which makes it unlawful to "place where it can pass into the waters of this state* * *."

The present day regulations are in considerable contrast to the story heard a few years back revealing the probable instructions given to the crew of a foreign vessel with the hope of "getting by." On being apprehended while pumping oily bilge water in a local harbor the alibi given was, "we thought it was O.K. since the sun had gone down, for we understood the California law required bilges to be pumped at night."

It is impossible to estimate in dollars and cents the enormous amount of damage done annually along our coastal waters and beaches from petroleum products originating from wells, refineries, fueling terminals, bilge and ballast pumping and other sources. This damage is not to marine life alone but affects fishing, hunting, aquatic sports and all beach recreation, together with the ever present fire hazard.

Figure 47 is a good illustration of conditions resulting from bilge pumping or from careless fueling as shown in figure 48. Imagine spending hours planning a family holiday and then have the children tarred and sanded as shown in figure 49. Can you guess what mother said while trying to do the Monday wash? Or, what dad had to say while repainting his boat and cleaning the line and reel after rowing through a patch of California's "black gold"?

And now consider for a moment one of the hazards to marine life. Figure 50 shows the highly prized grunion, *Leuresthes tenuis*, during the spawning period on a sandy beach. These fish spawn at peak tide, and the eggs remain in the sand to hatch at another high tide some two weeks later. The presence of oil on the beach while spawning or during the period of incubation is a definite threat against the existence of this species. The danger of death by oil applies equally well to other forms of aquatic life, both

FIG. 49. Children coated with oil and tar.

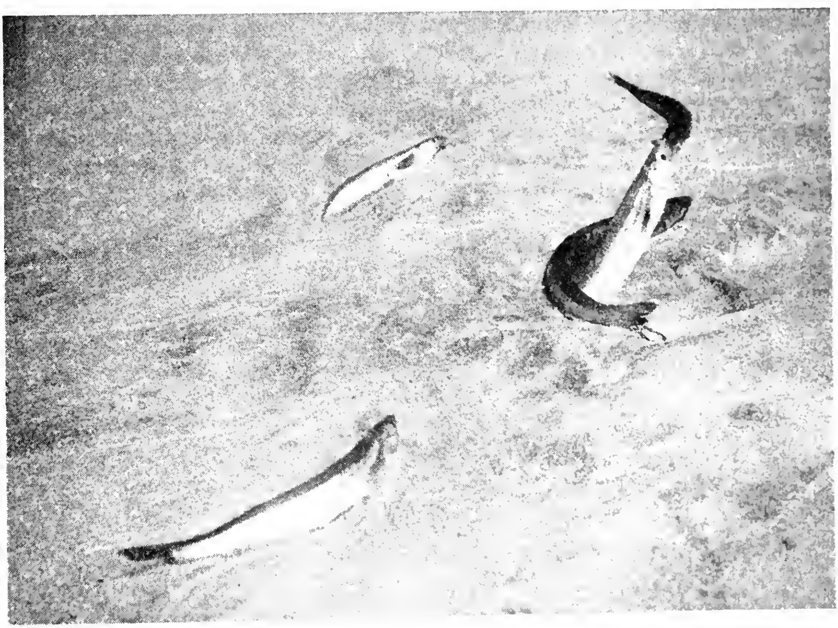

FIG. 50. Grunion spawning on sandy beach. Photograph by "Dick" Whittington.

in the water and on the tide lands. You will note in figure 51 how an oil operator will sometimes conduct his enterprise in such a deplorable way that the lightest of rains may carry surface oil to storm drains or sewers as shown in figure 52, from there to eventually flow into State waters (Fig. 53).

In certain instances our attention has been drawn to installations where thousands of dollars have been spent on a good start, but which

FIG. 51. State waters endangered by failure to provide safety measures controlling oil drainage.

FIG. 52. Oil flowing into storm drain.

through inadequate forethought have proved disastrous. For example, a perfectly constructed wall for a waste oil sump can be an engineering masterpiece to all appearances and yet prove faulty when Father Neptune gets a little angry. The situation in figure 54 would not have happened had the cement been laid to bedrock or deep enough to prevent the foundations being washed away. Again, a tank may appear

satisfactory to hold oil and yet not accomplish that purpose, as may be seen in figure 55.

Faulty installations as shown, and other sources of oil pollution, are responsible for huge losses of waterfowl yearly. The helplessness of an oil coated duck is shown in figure 56. Birds coated in this

FIG. 53. Oil flowing onto beach from storm sewer.

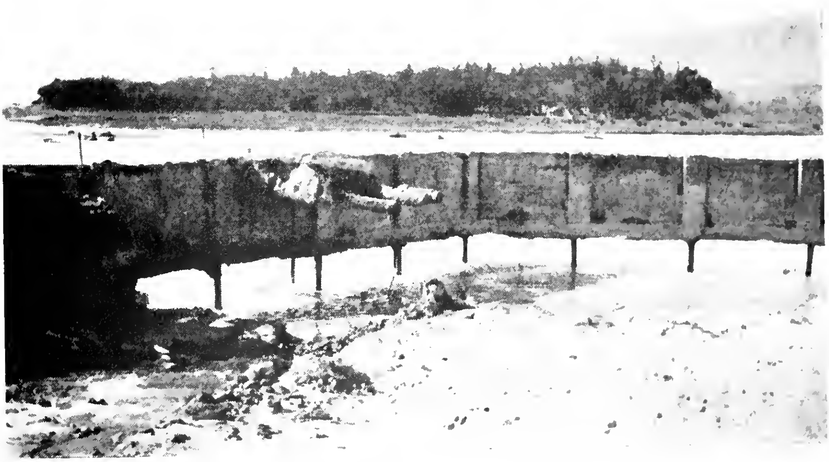

FIG. 54. Oil sump undermined by storm water.

manner seldom fly again and eventually die of starvation. Similarly, oil sumps often become death traps for birds as noted in figure 59. In such cases, burning the sump with the aid of lighter oil to form a solid crust or installing cross wires to discourage birds from alighting has been effective.

However, the situation is not quite so bad as the foregoing pages would indicate, and we do not wish to lay too much complaint at the door of one of our largest and most essential industries. This entire problem can be handled in a way to prevent damage to our natural resources and annoyance to the public, for experience with recommended methods of prevention indicates that the major sources of oil pollution can be eliminated by conforming to approved practice.

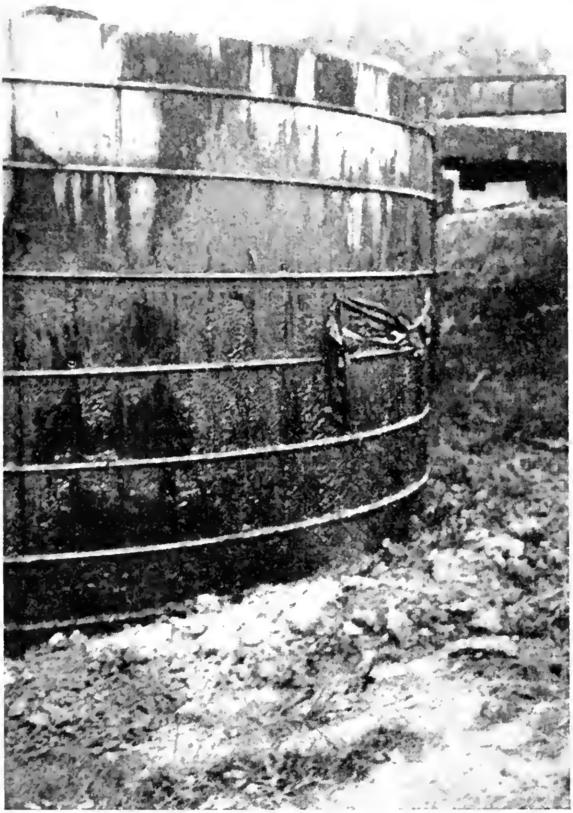

FIG. 55. Leaky oil tank.

The American Petroleum Institute, the membership of which includes a majority of the larger oil companies, carries on continuous investigations relative to proper waste disposal and has published a series of bulletins detailing procedures and installations constituting good practice. The recommendations of this group are an outstanding example of sincere effort on the part of an industry to prevent damage, and it may well be said that the major oil companies operating in California have cooperated to a high degree, spending thousands of dollars annually to comply with requests for improved facilities and preventative measures, and to aid us in every way possible.

Figure 57 indicates one type of separator installed for the purpose of removing oil from waste water. The accompanying diagram (Fig. 58) shows the essential features of one system for handling waste water contaminated by oil.

Separator skimming ponds and sumps of varied design and construction are maintained and operated as part of oil well, refinery, and railroad roundhouse practice throughout the State.

FIG. 56. Helpless, oil coated duck.

FIG. 57. An oil and water separator.

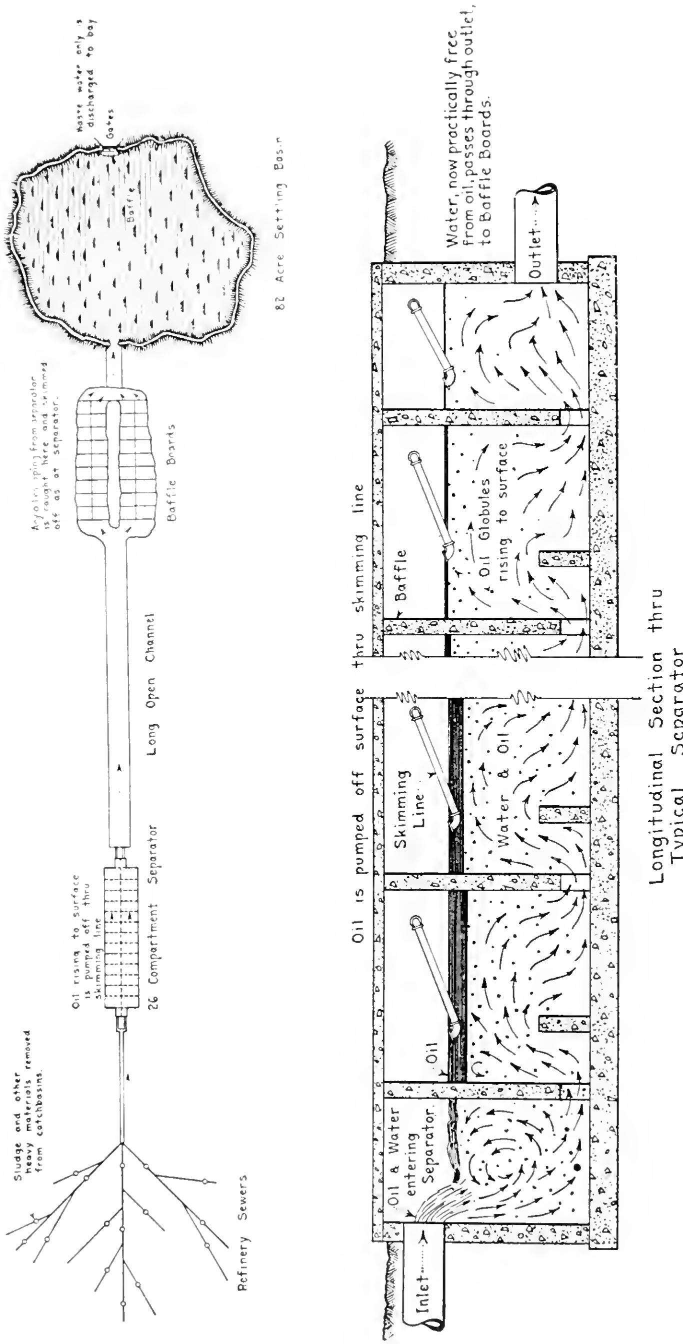

FIG. 58. Diagram of an oil separating system. Courtesy Standard Oil Company.

Fig. 59. This oil sump was a death trap for many birds.

Fig. 60. Boom for surrounding and controlling an oil spill.

A simple device installed at many marine terminals, ready for immediate use to localize and control a spill, is shown in figure 60. This boom can be rapidly brought into use from the rack to encircle a spill. Straw can then be placed on the oil, as shown in figure 61, after which the straw with the adhering oil can be raked together and burned. In a similar manner straw may be utilized for the clean up of an oil covered beach as shown in figure 62. In the event of a larger spill the main harbors have ship service companies equipped with suction pumps and separators on a barge for effecting a satisfactory clean up.

FIG. 61. Straw being used to clean oil spill on water.

In figure 63 you will note the drip pans now almost universally installed beneath terminal valves to prevent water contamination. In addition, the larger terminals are equipped with a ballast line for the purpose of conveying oily ballast water to adequate separators before discharge to State waters.

A cooperative plan in which concrete evidence and immediate action can be taken when oil is discharged in violation of Section 481 was initiated about two years ago and is being expanded rapidly. This plan includes harbor and coastal patrol by the Coast Guard and State, and provides for immediate reports from U. S. Customs officers. Arrangement for rapid action through the courts prevents undue holding of a ship in port. Essential evidence includes samples of oil from the ship or other source and from the water or beach; pictures indicating sampling locations and existing conditions, together with statements of witnesses of the violation. In many cases, analyses of samples, with data on tides, winds, currents, etc., forge an additional link in the chain of evidence. The attitude of the offender and his efforts to correct the condition or make

a cleanup are given considerable weight, and in some instances the violation may be prosecuted in Federal court.

While the term "factory refuse" includes waste from a hundred and one different plants that may be deleterious, objectionable or prohibitive in various ways, it seems desirable to mention a few problems under this general term due to the wording of Section 481.

In one instance where a fish cannery discharged large quantities of visible solids and sludge forming material, our efforts to secure a remedy resulted in the installation of a specially designed rotary screen which not only rectified a deplorable condition, as may be noted from figures 64 and 65 taken before and after this was effected, but also resulted in the plant recovering valuable products, formerly lost, which soon paid for the entire installation. Other plants are now putting in similar equipment.

Wastes containing sludge forming material are extremely deleterious due to gas formation during decomposition, change of bottom environment, and reduction of available oxygen. A water area in which this condition exists is pictured in figure 66. The masses of sludge which are being continuously buoyed to the surface through the accumulation of decomposition gases may be seen in this picture. Here again, analysis indicates that the waste contains appreciable quantities of valuable material, and steps are now under way to remedy the situation.

Fig. 62. Straw being used to clean oil spill on beach.

Many times a waste disposal, such as that from the milk plant shown in figure 67 will be practically invisible when discharged into State waters, but at some point down stream, perhaps several miles below the outlet, the resulting oxygen depletion may establish a complete barrier to fish migrating up or down stream. Figure 68 indicates a gravel filtration area installed at one such plant. Along the Eel River where dairy wastes were a major pollution factor, several

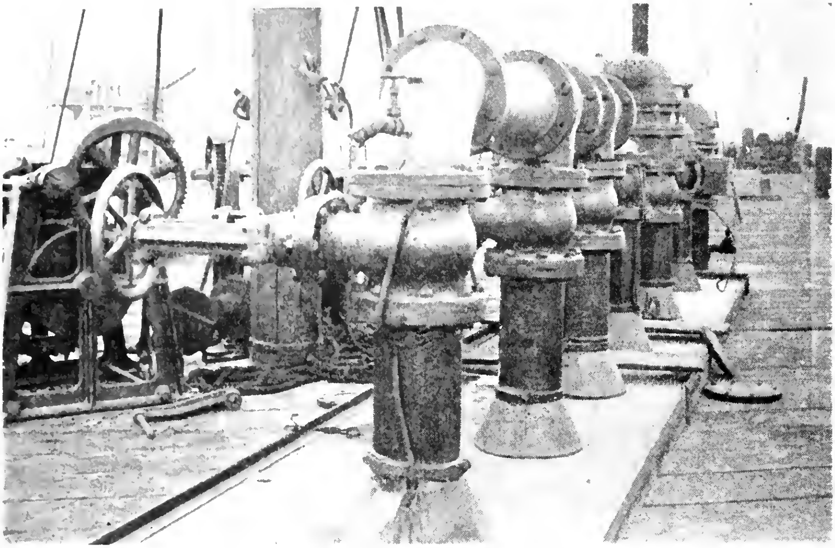

FIG. 63. Drip pans installed below valves to prevent leakage into the water from oil loading dock.

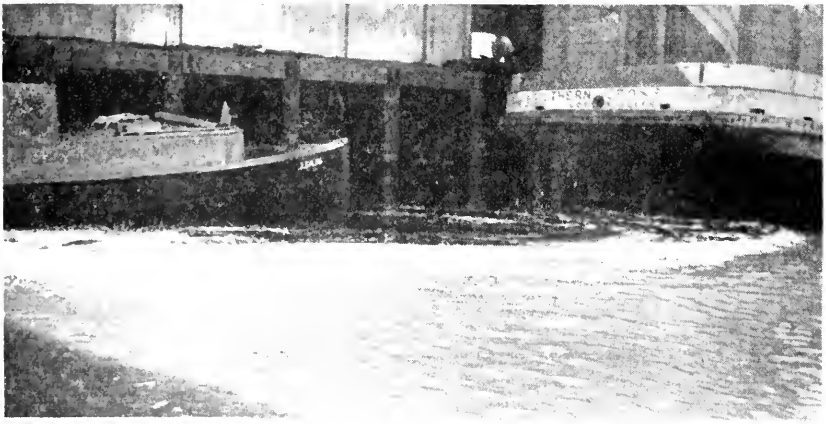

FIG. 64. Factory refuse on water.

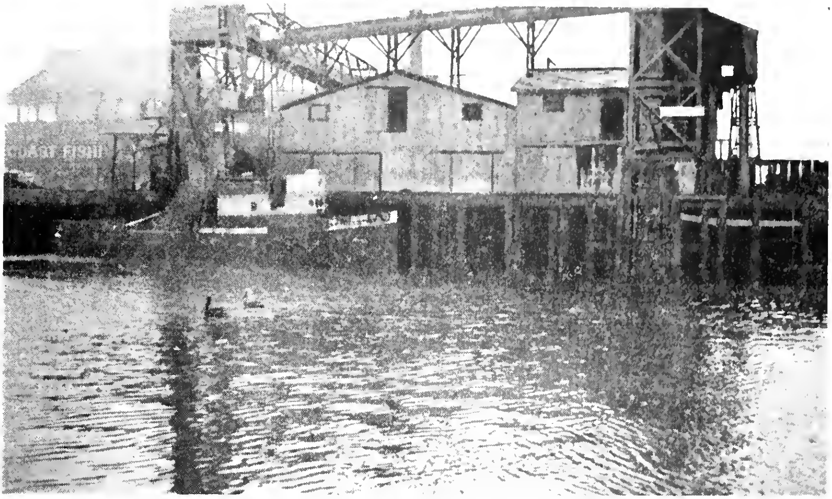

Fig. 65. Clean water at same factory after installation of rotary screen.

Fig. 66. Patches of sludge brought to surface by fermentation gases.

measures, including distribution on alfalfa fields, installation of traps to collect entrained vapors from whey evaporators, and other devices, were responsible for greatly improved fishing and aquatic conditions in this well known salmon and steelhead stream.

The waste disposal from wineries in certain areas of the State has resulted in similar polluted conditions, producing heavy growths of objectionable fungus, destroying fish life, and establishing barriers from decreased oxygen at points forty miles down stream from the source of pollution. Detailed studies led to a restricting order which resulted in the California Wine Institute launching a program to find adequate methods of disposal or purification, and during the 1937 season, at least four different types of experimental treatment will be in operation. Whether any products of value to the industry will be recovered is yet to be determined. Figure 69 shows an area utilized for land disposal of winery wastes, but failure to maintain adequate dykes caused breakage, allowing the waste to flow into and pollute a nearby stream.

FIG. 67. Waste discharged from a milk plant.

One problem of factory refuse which has not as yet been given the attention it deserves is that from the fruit and vegetable canneries. The condition of one inland stream during the asparagus season may be noted in figure 70. Along a similar line, let us draw your attention for a moment to the thoughtless habits we encounter with respect to the disposal of domestic garbage, where, as noted in figure 71, this refuse after deposit in coastal waters has been carried by tides and currents to the beach. This brings to mind Webster's definition for the word "unclean," meaning "dirt out of place." We realize that garbage may be termed a necessary by-product of civilization, but, like a cow on a dance floor, is decidedly out of place when deposited in State waters. In this regard we sincerely solicit the unselfish cooperation of city, county and other officials to help solve this nuisance.

While the control over disposal of domestic sewage is largely in the hands of the Sanitary Engineering Bureau of the State Department

FIG. 68. Gravel bed installed for filtration of milk waste.

FIG. 69. Land disposal of winery waste. Note broken levee.

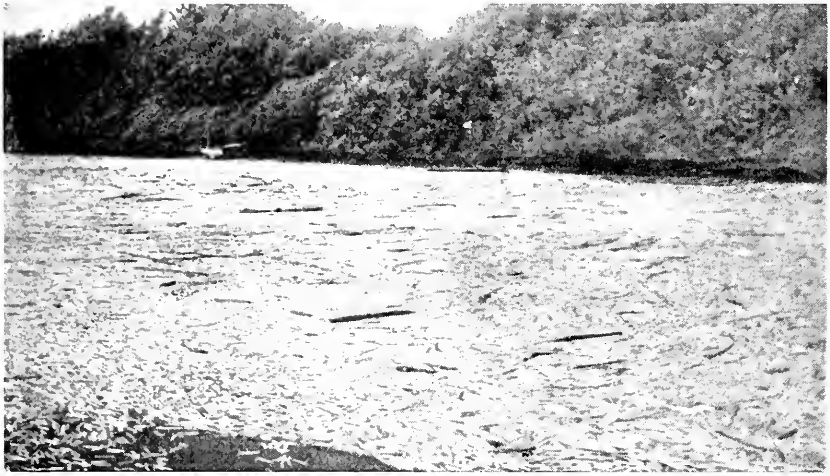

FIG. 70. A river covered with asparagus butts during cannery season. Photograph courtesy of *Sacramento Union*.

FIG. 71. Garbage on one of our ocean beaches.

of Public Health and local health districts, yet in several instances, improvements in disposal methods have been effected through our assistance. Marked progress in eliminating pollution from this source has been made in the past few years, but much yet remains to be accomplished.

It is generally conceded that the mining industry has been one of the chief factors in the upbuilding of this State, and, like other industries, it had its days of depression. However, it was one of the first to start back up the ladder and today many new mines are being operated and old ones are again active. In former days mining was conducted to a large extent in unfrequented mountain areas and the problem of damage to fish life was not forcibly brought before the public. The question of damage to ranchers from hydraulic mining

FIG. 72. A gold dredge.

debris is a well known chapter of California history, and this form of mining is now regulated to a certain extent through the California Debris Commission, a branch of the U. S. War Department, which has jurisdiction in so far as the debris may be deposited in navigable waters.

With the present boom in mining, and with new highways leading to all sections of the State, the question of handling waste water from mining operations is one of major importance and surveys indicate that more attention must be given each day to this industry which not only depends on natural resources but may also destroy others if permitted to operate without restriction.

In the Trinity and Klamath river area, Section 482 of the Fish and Game Code prohibits hydraulic mining and restricts other types of mining on the basis of river clarity from July 1 to November 30, the primary purpose of the law being to provide satisfactory fishing conditions during the run of salmon and steelhead. A dredger and a

gravel pit operation, typical of mines in this area that have been able to continue through the restricted season by impounding or filtering their waste water, are shown in figures 72 and 73.

Tailings from quartz mills and similar mines are particularly deleterious to fish life and may render a stream unfit for any normal use. In a number of areas, this material has been discharged into State waters without any attempt to clarify or settle out the pulver-

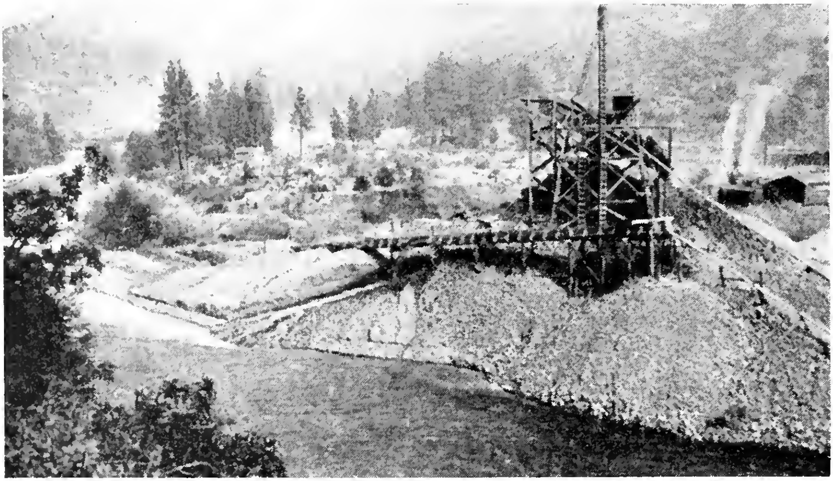

FIG. 73. Gold mining on a gravel bar.

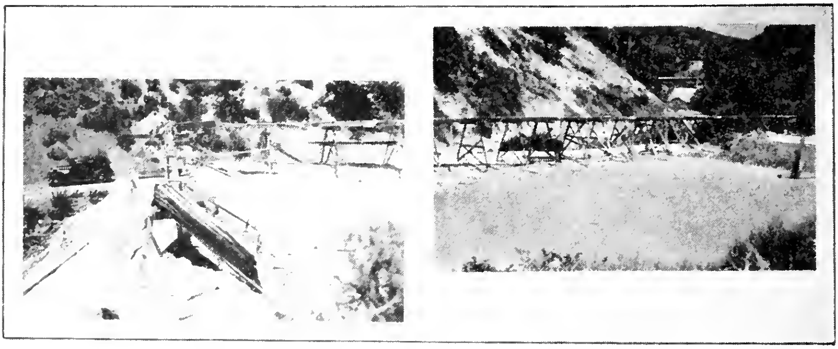

FIG. 74. One method of impounding mill tailings.

ized and spent ore which it contains. Active steps in all parts of the State where such conditions exist are being taken to remedy the situation. The impounding of mill tailings is a relatively simple and inexpensive procedure, for by proper distribution from a flume, the tailings can be partially utilized to form their own levee, as indicated in figure 74. However, the installation shown is not satisfactory, since the levee is directly below the flume and an overflow would result in break-

age, causing an avalanche of tailings and debris, sweeping all fish life with it, and covering stream bottoms to a considerable depth, thereby destroying aquatic organisms, the basic food supply of fish. Care in properly locating a tailings pond so that storm waters will not flush it out, and care in maintaining it in such a way that the high point of the levee is well outside of the distributing system are essential necessities. Figure 75 indicates a tailings pond that has not been adequately protected. Figure 76 shows a stream into which mill tailings have been allowed to flow and you will note the extent to which the rocks are covered and the general slimy appearance of the water.

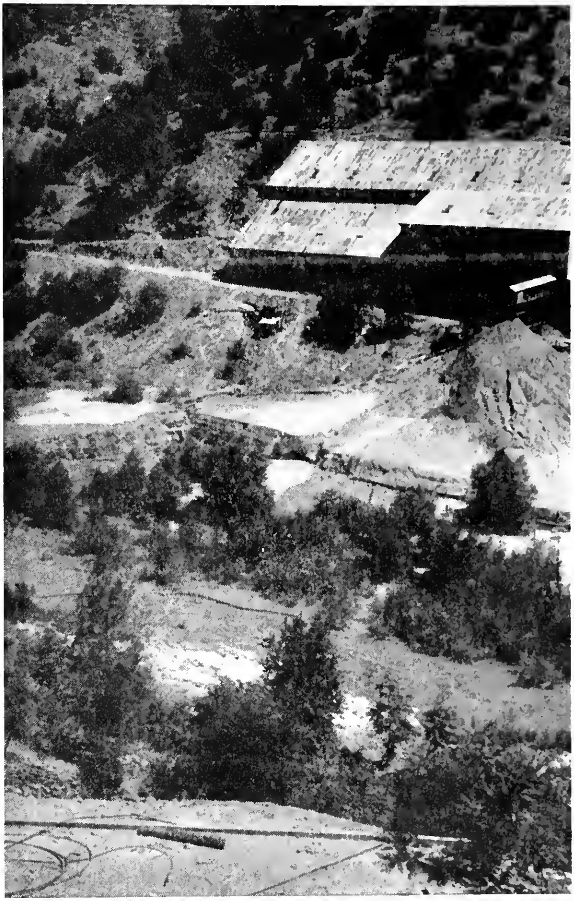

FIG. 75. Poorly impounded mill tailings.

In many instances the waste water from mining shafts or mill operations may contain acid, metallic salts or other chemicals which are extremely poisonous to aquatic life. Copper and zinc may be mentioned as two such elements which must be rigidly controlled to prevent contamination of streams. Recently a mine which had not been operated for a number of years was reopened and the first procedure consisted of pumping out the tunnel shaft. The chemicals contained in this water were so poisonous that fish were killed for a distance of 60 miles downstream. Obviously, immediate action was necessary in this case and operations at the mine were closed down until proper measures were taken to safeguard the stream against further contamination. Figure 77 shows dead fish resulting from such a catastrophe. However, as with certain other industries there appears to be a tendency toward regulating their own group in an effort to prevent damage to natural resources.

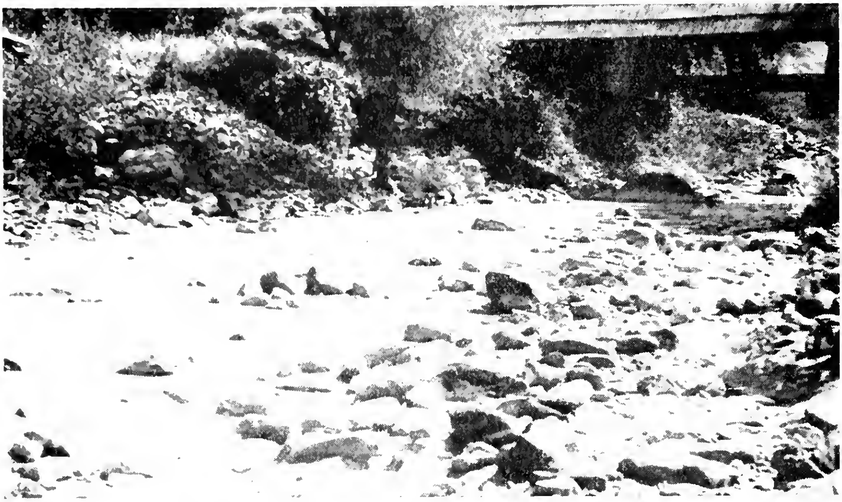

FIG. 76. A fine stream ruined by mill tailings.

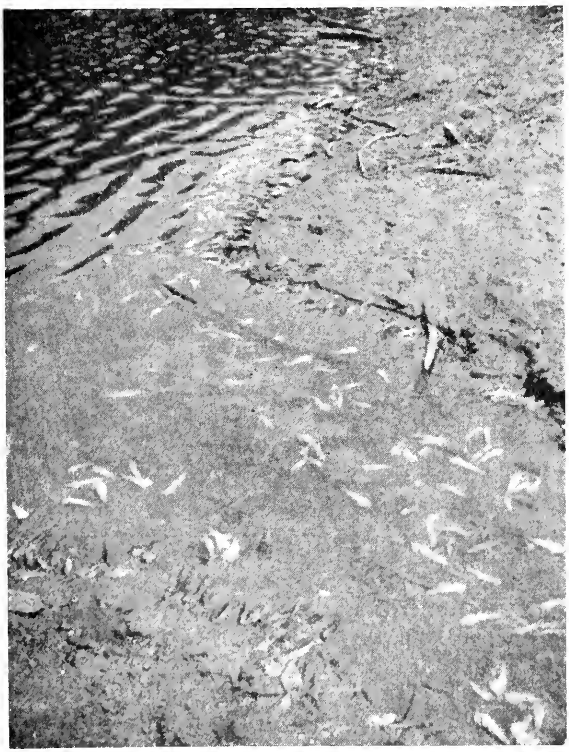

FIG. 77. Dead fish from polluted water.

From time to time the streams in our timber country become contaminated with sawdust or other sawmill refuse. The placing of such material in State waters or depositing it where it can get into State waters is strictly prohibited and the necessary action is strictly a matter of law enforcement. Sawdust is deleterious to fish life both from the standpoint of poisonous substances extracted by the action of water and also through irritation and damage to the gills by mechanical action. Figure 78 shows where sawdust had been deposited in a gulch close to a

fishing stream into which it would be washed by the first rain. At the time this picture was taken an attempt was being made to burn up the sawdust as indicated by the smoke in the picture. An overhead conveyor which had been installed at our request to keep sawdust out of the channel may also be noted.

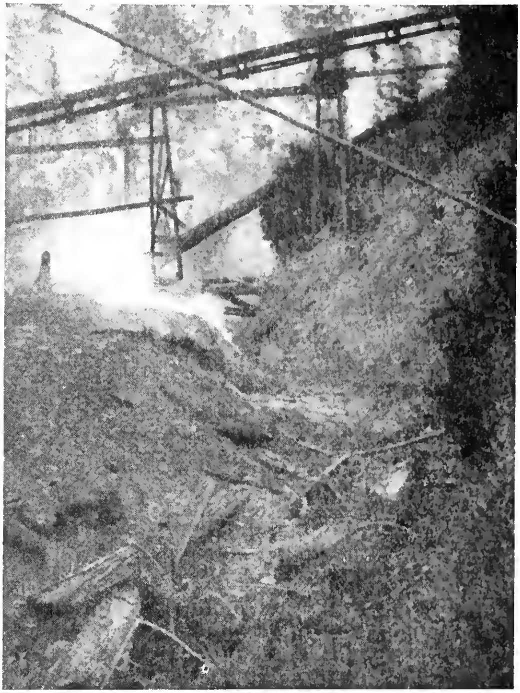

FIG. 78. Sawdust deposited in stream bed.

Additional types of pollution might be described, but we believe that the foregoing is sufficient to indicate that control over pollution of State waters is an ever present problem that will require continuous and vigorous attention as population and industry continue to grow. In attaining the goal of preserving fish, game and other natural resources for the benefit and enjoyment of present and future generations, we do not in any way want to place an undue burden on any private enterprise, but conversely, private enterprise should not place an undue burden on the people of the State.

In conclusion, we would like to thank publicly those agencies who have so willingly cooperated with us, and in particular the U. S. Coast Guard and U. S. Customs.

NOTES ON THE DEER OF CALIFORNIA REDWOOD STATE PARK [1]

By Robert T. Orr,
California Academy of Sciences

During the late spring and summer of 1935 considerable opportunity was afforded to make observations on the life history of the Columbian black-tailed deer, *Odocoileus hemionus columbianus,* in California Redwood State Park. While most of these observations were made with the practical purpose in mind of arriving at some satisfactory solution concerning joint occupancy of this recreational area by man and native species, such as deer, certain interesting features in connection with the natural history of the latter were obtained. Deer, particularly, are of such economic importance as game and vary so much in habits, geographically, that there always appears to be justification for adding further to our knowledge of their behavior.

The California Redwood Park is one of the largest State parks in California, composed of approximately ten thousand acres of land situated in the west-central part of the Santa Cruz Mountains. The area, in general, includes the greater portion of those western-flowing drainage systems which are naturally limited to the north and south by Butano Ridge and Ben Lomond Mountain, respectively.

The floral composition of the Park varies to a considerable extent. There are extensive tracts of redwood forest, woodlands, some cut-over areas and a large number of arid, rocky, chaparral-clothed ridges. Deer were found to be most abundant in oak-madrone woodlands where there was a fair amount of underbrush combined with small clearings. Chaparral-covered slopes and burned-over land where second growth timber and invading brush types were present likewise offered favorable habitat for members of this species. The redwood forested canyons proved to be the least desirable cover for deer, although in the central camping area in Big Basin, deer were found to be present in numbers, having been attracted there as a result of artificial feeding.

A conservative estimate made by the writer in regard to the number of deer present in the park was 250. This is equivalent to 16 deer per square mile or one for every 40 acres. This figure was obtained during June, 1935, by careful and repeated counts on a number of sample areas, including various habitats. Only adults and yearlings were taken into account. Young of the year were not included; consequently this represents the lowest ebb in the annual population. Furthermore, as certain portions of the park were far more favorable for deer than others the number of deer per square mile in such areas was considerably greater than in other less suitable situations.

[1] Submitted for publication, July, 1937.

Throughout the spring and summer months the following plants were found to be most important as food for deer: canyon oak (*Quercus chrysolepis*), California lilac (*Ceanothus thrysiflorus*), *Ceanothus papillosus,* buck-brush (*Ceanothus cuneatus*), salal (*Gaultheria shallon*), huckleberry (*Vaccinium ovatum*), madrone flowers (*Arbutus menziesii*) and various edible grasses.

Canyon oak and grasses, when available, were selected in preference to all other types of vegetation. In places where the canyon oaks were well trimmed up from browsing it was not uncommon to see deer standing on their hind legs in order to reach the lower limbs. On chaparral slopes buck-brush was of next choice, whereas in and around the redwood forest and especially where there was a second growth forest, *Ceanothus papillosus* and *Ceanothus thrysiflorus* were also important food plants. Salal and huckleberry appeared to be

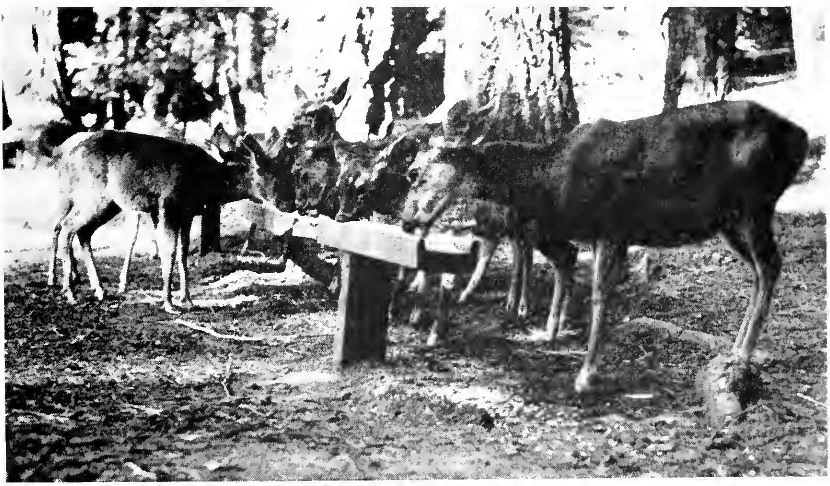

FIG. 79. Deer attracted to a feeding table at Governor's Camp, California Redwood State Park. Photograph taken in spring, 1936, published through courtesy of the U. S. National Park Service.

less desirable for food. They were chosen as a rule when other more palatable species were lacking.

Where grassy clearings or meadows were present, small groups of deer were found to congregate during the early morning and evening feeding hours. The size of these groups varied from two or three individuals in small clearings, as in burned-over land, to as many as 15 in natural meadows 150 yards or more in diameter. The brush surrounding these grasslands was browsed much more heavily than elsewhere. This was accounted for by the fact that the deer fed for some time on this brush, both before coming out into the open and again after the period of feeding on grass was completed. Likewise, individuals were seen to leave the grassland occasionally for short periods of time to browse on the nearby brush and lower limbs of oaks.

Most of the young are born in this region between the middle of May and the end of June. On May 22, 1935, the first fawn of the year was reported as seen, and from this date on they were noted

daily in increasing numbers. By the end of June the writer estimated that approximately 80 per cent of the does had borne young. Twins were found to occur in about 20 to 30 per cent of the cases.

Due to the protection afforded deer in California Redwood State Park and the attempt made on the part of park authorities and visitors to cultivate their friendship, there is practically no sign of fear exhibited toward man by these animals in this region. This statement does not apply, however, to young of the year. For a number of weeks after birth the young of relatively tame parents showed a very definite fear and distrust of people. While the mothers would feed out of one's hand, the young at this early stage would stand a considerable distance away and at the slightest provocation dash off in a series of jumps to the nearest brush. This behavior seemed to indicate that fear of man is a natural instinct which must be overcome in these animals rather than a fear developed through the life of the individual due to unfortunate contacts with the human species. Yearlings, which were often seen following does before the latter gave birth to young of the year and even to some extent after, were as tame as adults.

The only times that voice was recorded was when does were attempting to call their fawns. On such occasions they were heard to give a low bleat, not unlike that of a sheep.

The reaction between deer and raccoons in the camp grounds at night, particularly around garbage containers, presented some rather interesting aspects. As both these species are relatively common here and have equally developed a relish for certain types of food deposited in garbage cans, they frequently come into conflict with each other. Repeated observations made at night by the writer at these points of controversy showed a mutual feeling of distrust to exist between members of these two species. The deer, when disturbed by raccoons, would continually attempt to strike the intruders with their fore feet, and would not eat if any of the smaller animals were close behind them. The latter also distrusted the deer and often tried to nip their heels. The deer being the larger were more often the victors. Three or four raccoons, however, frequently so disturbed a deer that it would go away and leave the food to the former.

The custom on the part of park officials at Governor's Camp of supplying deer with food daily has been carried on over a good many years, resulting in the accumulation of a band of tame deer which are to be found in or close to the camp all year around. The effect of this has been both good and bad.

Visitors, especially those who are casually driving through the park or who stay for the day, are usually thrilled at the opportunity of approaching close to these creatures of the wild and having them take food out of their hands. Observation at such close range is likewise educational, both to adults and to children, many of whom have their first view of this species at the camp.

On the other hand, let us consider some of the detrimental effects that this artificially produced band has brought about. First, it is not true to nature. This fact must be borne in mind if we hope to make our parks into areas where all the component elements are preserved in or as nearly in their original state as is possible.

Under normal conditions deer would not be apt to congregate in the area where the camp is located, due to the presence of people, the denseness of the forest, and the scarcity of native food plants. The last mentioned point is of particular importance. The clearing in the camp center, around which most of the administrative buildings are now situated, was originally somewhat boggy in nature. Rushes and sedges, both of which are rather unpalatable to deer, formed the dominant vegetation. Very few canyon oaks occur in the surrounding redwood and Douglas fir forest and the situation is not suitable for the growth of *Ceanothus.* Hence, salal and huckleberry, two of the less desirable food plants, remain as the principal native types of food upon which deer must rely.

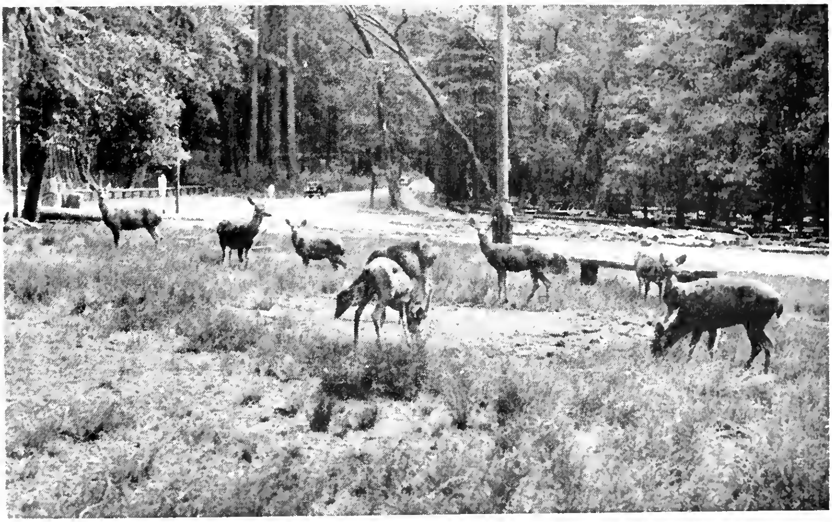

FIG. 80. A portion of the band of deer which constantly remains in the vicinity of Governor's Camp. Note how closely the grass has been cropped, although the sedge is largely untouched. Photograph taken in spring, 1936, published through courtesy of U. S. National Park Service.

The few canyon oaks which remain around Governor's Camp are well trimmed up and any young trees which now try to grow are eaten before they rise more than a few inches above the surface of the ground. This denuding effect on the vegetation, caused by an over-abundance of deer combined with the great concentration of people tramping over the region during the summer months, has caused a very serious depletion of the ground cover. Furthermore, it has made those deer, which stay constantly in this defined territory, dependent to a large extent upon the food which they are given by the Park officials and by campers and visitors. Since this food is of a wholly unnatural type and the native species of vegetation that deer feed upon are not those that are preferred, it is questionable as to the benefits derived from this practice. Experiences in our National Parks have shown that, invariably, disastrous results occur when man, with well meaning intentions, tries to direct the course of nature and cultivate too close a friendship with native wildlife.

SEVENTH ANNUAL BLACK BRANT CENSUS IN CALIFORNIA[1]

By JAMES MOFFIT,
California Academy of Sciences

For the seventh consecutive year, counts of black brant, *Branta bernicla nigricans,* were made during February, 1937, on the bays along the California coast where the species is known to winter. As in previous years, censuses were taken in Bodega, Tomales and Drake's bays on February 10; but elsewhere, due to circumstances which prevented the members of the Division of Fish and Game from participating on this day, counts were not made until February 15. This year Game Warden Earl Caldwell, a new cooperator, took the census on Humboldt Bay, otherwise counts were made by observers who had participated in previous censuses. The cooperators are named under the reports for individual areas, and grateful acknowledgment is hereby made for their assistance.

HUMBOLDT BAY

Game Warden Caldwell, counting from a boat on this bay February 15, 1937, a clear calm day, secured what he considered to be an accurate census of the brant present on North and South Humboldt Bay, a total of 22,500 birds. Tides on the bay (South Jetty Landing) this day were as follows: low tide, 9.10 a.m., 0.6 ft.; high tide, 3.09 p.m., 5.1 ft.

This year's census total is less than half the number of brant found on Humboldt Bay, February 10, 1936. The writer made estimates of the brant present on Humboldt Bay, March 1 and 3, 1937, when he was convinced that at least 30,000 individuals, perhaps many more, were present. At this time conservatively 20,000 birds were found in the southeastern arm of South Bay, from Fields Landing to Table Bluff. Undetermined large numbers of others were seen, too distant to count, along the western shore of the bay, while 10,000 more were estimated present on North Humboldt Bay on these days.

These observations indicated that maximum brant concentration was not reached on Humboldt Bay until after the census date, February 15, 1937.

BODEGA BAY

J. M. Linsdale, University of California Museum of Vertebrate Zoology, counted the brant on Bodega Bay for the sixth consecutive year. The 1937 census was made on February 10 in the two hours preceding noon. A strong southeast wind made but little disturbance on the water and tended to concentrate the birds near the southeast shore where the observer found accurate counting practicable. Repeated counts gave totals of 1200 to 1400 birds in flocks, with enough

[1] Submitted for publication, August, 1937.

scattered individuals present to make the total on the bay approximately 1500 brant. The tides on this bay were essentially the same as recorded below for Tomales Bay.

TOMALES BAY

R. T. Orr, California Academy of Sciences, and the writer took the census on this bay from 9.30 a.m. to 1.30 p.m. of February 10, 1937. During the first two hours, the birds were feeding in a mass in the center of the bay north of Hog Island, where accurate counting was impossible. Later, as the tide receded and the southeast wind increased, most of the birds came close to or on shore, between Hamlet and Toms Point (see Fig. 73, Calif. Fish and Game, vol. 18, 1932, p. 301). Here, a satisfactory count was procured. Notable in this day's census, as contrasted with previous ones, was the almost complete absence of brant on the Outer Bay, north of Toms Point, where but five individuals were found. Sixty brant were found alongshore between Hamlet and Blake's Landing, a mile and a half south. Otherwise the birds were confined to the area between Hamlet and Toms Point. At the end of the census, 610 brant were counted, bird for bird, on the mud at the mouth of Walker Creek, just northeast of Hamlet. Some of these were less than 100 yards from the observers. The total for the census on this bay was 1556 brant; but a later report from Linsdale, who passed by Hamlet shortly after we finished counting, that he saw several hundred birds which had apparently flown in from the ocean alighting on the bay north of Hog Island, indicated that we may have missed some of the birds in our census. It is conceivable that these birds may have come from Bodega Bay, rather than from the ocean. We attempted to go out on the ocean in our small boat at noon time, but the strong wind and heavy seas prevented. We saw no brant on the ocean, which appeared to be too rough for them to rest upon in comfort, nor did we in the entire census period note a single flock of these birds crossing the bar between Tomales Bay and the ocean.

Tides at the entrance of Tomales Bay, February 10, 1937, were as follows: low tide, 4.15 a.m., 2.4 ft.; high tide, 11.53 a.m., 5.0 ft.

DRAKE'S BAY

Game Warden Bert Laws counted the brant on this bay from daylight, 6.30 a.m., to 7.30 a.m. of February 10, 1937. He found the surface of the bay rough from a fresh southeast wind and the birds scattered in open water. Before it was light enough to start counting, Laws noted several flocks of from 50 to 75 brant rise, circle and head northwest, presumably going to the ocean or to Tomales Bay. His count indicated that after these had left, there were approximately 1500 brant remaining on the bay. If the brant that departed before daylight from Drake's Bay went to Tomales or Bodega bays, they were included in the censuses for those points, since same were not commenced until later in the morning. Tides on this bay were of essentially the same range as, but 45 minutes earlier than, recorded above for Tomales Bay.

J. E. Cushing, Jr., who took the 1936 census on this bay, was unable to do so on the appointed date this year, but he counted the

brant on Drake's Bay, February 15, 1937. This was a clear day with north wind. The tide was 4.4 ft. high at 2.45 p.m. and the count was made from noon until 3.00 p.m. The result, 2579 brant, is of interest in comparison with Laws' much smaller total secured five days earlier. It tends further to indicate that the numbers of brant fluctuate widely on Drake's, Bodega and Tomales bays, due, no doubt, to their interchange among the bays, and again emphasizes the necessity for making coincident censuses in this area.

MORRO BAY

The census at this locality was taken by A. P. Marshall and Game Warden F. W. Hecker, both of San Luis Obispo, on February 15, 1937. Weather conditions were ideal for the undertaking and the bay was quite smooth. The count was made after a low tide of 0.7 ft. at 7.30 a.m., from a vantage point on shore with the aid of binoculars. Each observer counted independently. Marshall's total was 5352 birds and Hecker's was 5331. The close agreement of the tallies confirms these observers' conclusion that they were able to secure exceptionally accurate counts by reason of the birds' scattered, yet undisturbed, positions over the bay. For sake of conservatism, Hecker's lesser total of 5331 birds is used for the 1937 census at Morro Bay.

After completing the count at noon, the cooperators went north along the coast, past Cayucos, Cambria, San Simeon and Piedras Blancas to Arroyo Cruz, looking on the way for brant in the off-shore kelp beds. Thirty-five birds were found close to shore, midway between San Simeon and Piedras Blancas; no others were seen.

MISSION AND SAN DIEGO BAYS

L. M. Huey, San Diego Natural History Museum, who has made four of the six previous brant counts on these bays, once more cooperated this year, with the assistance of Game Warden E. H. Glidden of San Diego. The census was made from 10.00 a.m. to 1.30 p.m. of February 15; during this interval, the tide was high at 4.2 ft. at 11.56 a.m.

Although it was found impossible to make bird for bird counts, both observers agreed that their estimates, as here provided, represented very conservative ones for the birds present this day. On Mission Bay, 450 brant were found in three groups, one to the east and two to the west of the Causeway. Between Santa Fe and Cottonseed points, on the east side of San Diego Bay near the mouth of Sweetwater River, a group of 350 brant were found. This total, 800 birds for the two bays, far exceeds the highest of any of the previous censuses (161 brant were counted on both bays in 1934). It is especially encouraging, because observations by Glidden previous to the 1937 census, indicated that the birds were established on San Diego Bay for some time. Glidden advised me by letter dated January 22, 1937, that on the afternoon of January 20, he found approximately 800 brant near the old cottonseed plant on the east side of San Diego Bay. The following morning at daybreak, 280 brant were found in the same locality, where more arrived in small groups, until by 9.30 a.m., when Glidden had to leave, 325 birds were assembled.

These observations tend to indicate a regular repopulation of San Diego Bay in the spring of 1937, by a relatively large number of brant. The occurrence is most gratifying and it is to be hoped that the birds will return next year. A number of years ago, the bay was the winter rendezvous for thousands of brant, but it has been many years since so many individuals have been recorded from this area as in 1937. In recent years, brant have appeared on San Diego Bay only sporadically, in small numbers, and did not remain for long. These groups probably represented migrating birds. The fact that about 800 brant apparently occupied this and Mission Bay for a period of nearly a month, possibly longer, is decidedly encouraging for the successful reestablishment of the species as a regular winter sojourner to the area.

TABLE I

Recapitulation of the California Black Brant Census, 1931–1937

Locality	1931	1932	1933	1934	1935	1936	1937
Humboldt Bay	Unsatisfactory	29,415	5,000	16,860	115,000	50,000	22,500
Bodega Bay	None made	3,200	977	1,298	3,700	350	1,500
Tomales Bay	9,445	6,285	7,409	5,565	6,850	9,175	1,556
Drakes Bay	None made	2,108	318	2,189	1,995	1,500	1,500
Morro Bay	4,493	2,938	None made	3,895	7,544	5,000	5,331
Mission Bay	71	No birds	115	154	9	30	450
San Diego Bay	No birds	No birds	No birds	7	55	No birds	350
Totals	Incomplete	43,846	13,819	29,968	135,153	66,055	32,187

NOTES ON THE 1936-1937 BRANT FLIGHT

Observations, other than those previously provided under the census report for the area, are lacking as regards the brant migration at Humboldt Bay.

On a visit to Tomales Bay, November 1, 1936, no brant were seen in a careful search of the bay and adjacent ocean, nor did local residents report having noted the species, as yet. Returning to the locality on November 26, I estimated upward of 2000 brant present. These, local residents stated, commenced to arrive on November 15. No birds were noted prior to this date, when large numbers appeared and arrivals continued over three days until about 2000 birds were present.

On December 22, 1936, I estimated that there was approximately the same number of birds on the bay as in late November. By January 21, 1937, the brant population on Tomales Bay had increased to an estimated 3000 birds. It is to be noted that this total fell off by census time, February 10, to half that number of birds, and scarcely more than 2000 brant could have been on the bay at the time of a visit on March 14.

Three black brant, perhaps crippled or oil-incapacitated birds, were noted on Tomales Bay just north of Hamlet on June 25, 1937. These individuals appeared healthy and could fly well. The occurrence presents an exceptionally late spring record for the region.

Reports from Morro Bay, made by A. Silva, long time resident and brant hunter in this locality, kindly transmitted to me by Nathan Moran of San Francisco, indicated that the first brant was noted there in the autumn of 1936, on November 16. By November 28, the birds were abundant on the bay. No numerical estimate was made by Moran,

who hunted on this and the following day, but there were at least many hundreds of brant present and he had no difficulty in shooting the limit each day. As a matter of interest, tending to indicate the longevity of geese, is Silva's statement to Moran that he had observed presumably the same, peculiarly marked, albinistic brant on Morro Bay each winter for 23 years. The bird was killed there last November. If this was indeed the same individual, which seems quite probable, since reports of albinistic brant are few, it is of further interest in that it indicates that the same individuals tend to winter in the same locality year after year.

D. D. McLean, Economic Biologist, Division of Fish and Game, San Francisco, reported seeing a flock of from 150 to 175 brant flying south, over the ocean about a quarter mile offshore, near Oceanside, San Diego County. If these were migrating birds, their direction of flight was contrary to the usual one at this season when most brant noted off the California coast are seen to be working northward. Possibly the group McLean noted were part of the San Diego Bay assemblage, returning to that place from a visit to the ocean to the north.

Richard S. Croker, of the California State Fisheries Laboratory, kindly provided for use in this report, the following note concerning a seemingly seasonally late record for the species to be found in numbers in Lower California, as follows:

"On April 20, 1937, our boat *Bluefin* was at San Quentin Bay, Lower California. D. H. Fry, Jr., of the Laboratory staff, who was in charge of the research work on the trip, reported seeing brant in the Bay. The brant were not counted but there seemed to be considerable numbers present. In the words of Fry, 'there were certainly hundreds and perhaps thousands, but I would hesitate to estimate their numbers as we visited only a small portion of the Bay.' Fry was accompanied by John F. Janssen, Jr., and Richard B. Tibby, also of the Laboratory staff. San Quentin was the only bay visited during the course of this trip."

It should be observed that the above date, April 20, is about the time that the main aggregations of brant leave California bays for the breeding grounds. After late April, it is unusual to find numbers of brant on any California bay. In view of this fact the Lower California record is judged to probably be unusually late for quantities of birds. Perhaps brant remained later than usual in Lower California waters in the spring of 1937, possibly held there by an exceptionally abundant food supply. If this were the case, it would account for the late arrival of the birds at Humboldt Bay and for the failure of the usual January and February increase in numbers on Tomales Bay, providing that the theory advanced in previous reports, on the strength of considerable evidence, that our spring brant increase comes to us from the south, is correct.

SUMMARY

The 1937 census of black brant in California in mid-February indicated fewer birds present than in the two previous years and in 1932, but more than in 1933 and 1934. The greatest loss, numerically, over the 1935 and 1936 counts, was at Humboldt Bay. This, our northernmost brant bay, has been shown by the previous censuses to be the locality where maximum seasonal abundance is attained latest and it is

also here that the greatest fluctuations occur from year to year. In point of percentage of loss in 1937 over the previous year, Tomales Bay showed the greatest drop with only 1,556 birds against 9,175 in 1936; approximately one-sixth as many individuals, or a loss of about 83 per cent over the previous census. This year's total for Tomales Bay is over three times smaller than the lowest previous count, in 1934. Counts on the nearby Bodega and Drake's bays were about average, so can not help to make up for the deficiency of birds on Tomales Bay. Food (eel grass) appeared to be as abundant as usual in this bay. The Morro Bay total was about average and close to last year's. The exceptionally large number of brant, apparently established for some time, on Mission and San Diego bays, was a matter of much interest.

A seasonally late report of numbers of brant on a Lower California bay and lateness of the usual January and February northward flights to Tomales and Humboldt bays, may signify that brant remained in Lower California later in the spring of 1937 than in normal years.

Again, I would like to emphasize the importance of a thorough understanding of the manner of occurrence of brant in Lower California, before we can properly interpret their exceptional numerical fluctuations to the north.

THE CHANGING ABUNDANCE OF THE PACIFIC MACKEREL, *PNEUMATOPHORUS DIEGO* A PRELIMINARY BOAT CATCH STUDY [1]

By Donald H. Fry, Jr.
California State Fisheries Laboratory
Division of Fish and Game

This paper is divided into two parts: Part I gives the results of the study without going into the methods used in obtaining them, and Part II tells how the results were obtained. The second section is of necessity much more technical than Part I.

PART I

INTRODUCTION

At first glance it would seem that the total catch of any market fish would be an exceellent indication of its abundance, and that changes in the total catch, from year to year, would indicate changes in abundance. This would be true if the same number of boats fished with the same gear and the same amount of effort each year. Unfortunately that is something which never happens. The demand for a species may suddenly increase, more and more boats go into the fishery and the total catch keep rising, in spite of the fact that each *boat* is getting less and less fish as time goes on. Conversely many boats may desert one fish to go after another more expensive one and thus cause the total catch to decrease in spite of the fact that each boat which does stay is having excellent luck. From this, it is obvious that the catch per boat would be a much better indication of abundance than the total catch of all boats. To refine the method still further it is often advisable to use a selected group of boats, follow the catches of each boat from year to year, and make sure that none of the captains has thrown a figurative monkey wrench into the statistical machinery by doubling the number of set lines in daily use, by changing from a five-man hook and line crew to a 10- or 11-man purse seine crew or by any of a dozen or more similar things.

It is also necessary to make sure that the demand for the fish in question is great enough so that the boats are landing all they can *catch*. If the demand is so limited that the boats are merely bringing in all they can *sell*, it is obvious that the fluctuations in boat catch are going to indicate the market demand rather than the abundance of fish.

[1] Submitted for publication, September, 1937.

THE BOAT CATCH CURVE

In calculating the boat catch curve for the Pacific mackerel, a selected group of boats was used. All were purse seine and ring net boats which fished for the Los Angeles and Long Beach canneries. Only at these canneries was the demand great enough so that boats of any kind could sell all the mackerel they could catch, and only the purse seiners and ring netters fished at all consistently for the canneries. Confining the study to Los Angeles and Long Beach may seem like an undue limitation. Actually it is not, since this one small region accounts for over three-quarters of the mackerel landed on the entire Pacific Coast of North America.

The catch curve covers the four years from 1933 through 1936. It has only been since 1933 that even the cannery demand has been great enough so that the boat catches would reflect anything but market conditions.

Let us examine this boat catch curve (Fig. 81) and see what it has done in the course of four years of practically unlimited demand.

1933

Most of the boats used in compiling this curve did their first heavy mackerel fishing in 1933, and learned the game during that year. For that reason the 1933 figures are not comparable with the later ones. Had the crews been experienced in 1933, their catches would undoubtedly have been higher, but we have no way of knowing how much higher.

1934

During 1934 the boats caught more than in the previous season, consequently both the boat catch curve and the total landings show a marked rise (compare Figs. 81 and 82). The boats had their best fishing in this year.

1935

In 1935 increasing numbers of boats and increasing size of boats forced the total landings up to an all-time high for the Pacific Coast, but the boat catch shows a decided drop from the previous year.

1936

The drop in the boat catch during 1936 was very bad. Even the total landings show a slump.

1937

The boat catch curve for 1937 can not be calculated until the season is ended, but the total landings to date (September 1, 1937) are far below those for the corresponding part of any year since 1933 and all along the waterfront one hears complaints about the scarcity of mackerel; in fact, fishing is so poor that many boats are deserting the mackerel fishery and going after other species.

Note added December 22, 1937: The 1937 boat catch was under 42 per cent of the 1935 value; the total catch for the year will be about 55 million pounds.

CONCLUSIONS

On a previous occasion[2] the writer has shown that the Pacific coast fishing grounds have been forced to produce far more mackerel than the much larger and very heavily fished grounds of our Atlantic coast. So intensely have the California grounds been fished that there has been every reason to look for a collapse of the fishery.

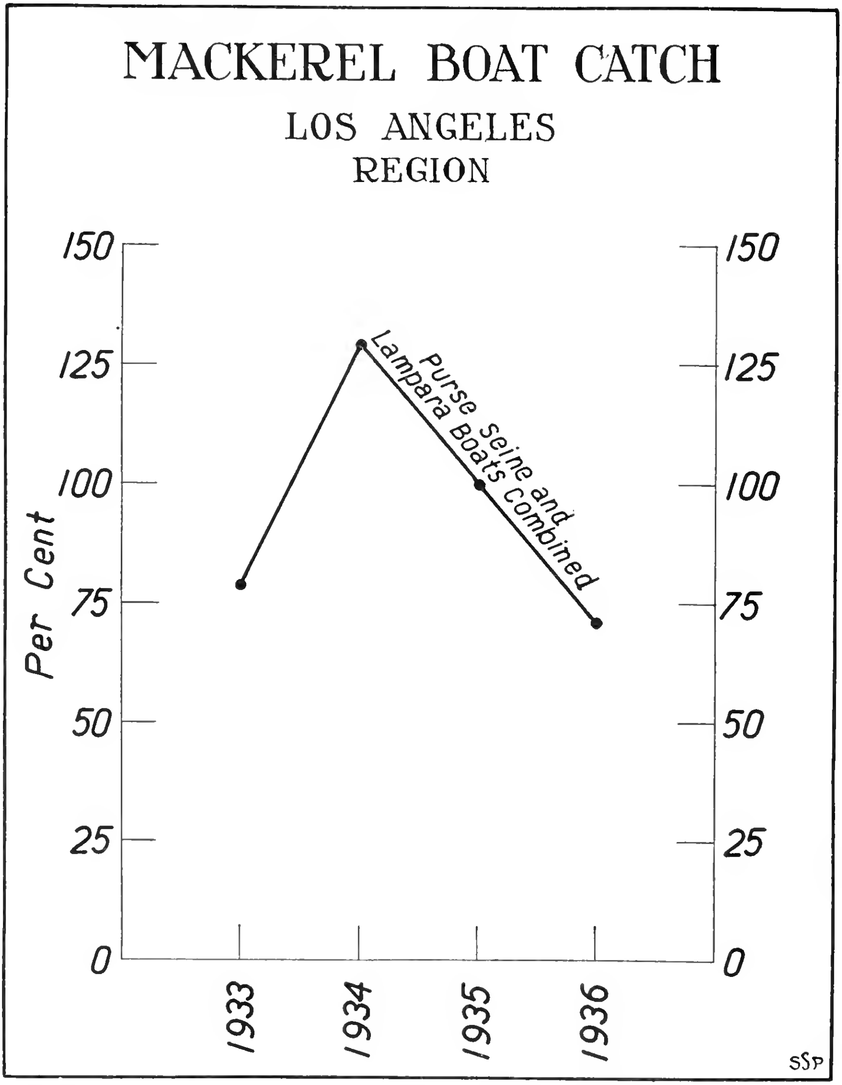

FIG. 81. Boat catches of the Pacific mackerel. Each year's catch is expressed as a per cent of the 1935 catch. The 1933 level is not comparable with the others, since most of the boat crews had to learn the business during that year and hence were not up to full efficiency.

---

[2] Mackerel catch is new Pacifiic Coast record. *California Conservationist*, vol. 1, no. 3, March, pp. 1, 20, 1936.

There seems no doubt whatever that in southern California the mackerel have been becoming steadily less abundant during the years since 1934. The only room for argument concerns the reason for this decline. One of the standard "reasons" given by fishermen for the disappearance of any species is that the fish are just as abundant as ever but have temporarily moved out of the fishing area. If the fish is an ocean species, this statement may be wholly or partly true. In any event, it is very hard to disprove. Four years' data are not enough to furnish such proof, but all the evidence we do have points to overfishing rather than natural fluctuations in a given area. Violent natural fluctuations tend to produce an irregular curve which jumps around without apparent rhyme or reason. The steady decline from 1934 to 1937 is far too regular. (The 1937 season is now nearly over and has been so poor to date that there is no doubt that both total catch and boat catch will be far below the 1936 level.) A gradual shift in population could cause this steady decline but the odds are against such a happening.

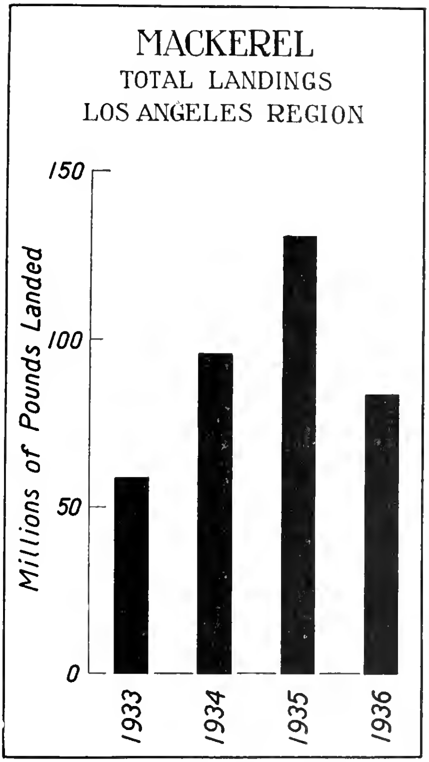

FIG. 82. Total landings of Pacific mackerel, Los Angeles region. This region takes over three-quarters of the mackerel landings of the entire Pacific Coast. An increasing number of boats kept the total landings on the up-grade until 1935, although the catch per boat had slipped during that year.

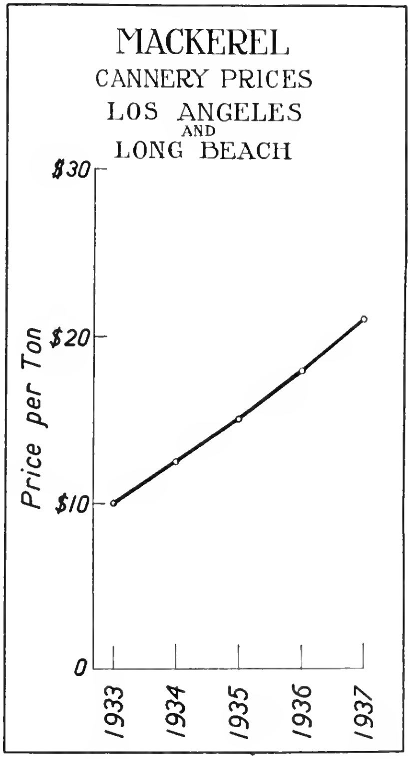

FIG. 83. Mackerel prices at the Los Angeles and Long Beach canneries from 1933 to 1937. The 1933 price of $10 per ton was raised to $12.50 about September 1 of that year.

If we wait long enough to obtain absolute proof about the decline, and meanwhile fishing continues to fall off at the present rate, we will be arguing about a commercially extinct species. Whenever we take into account the intensity of fishing *and* the trend of the boat catch figures, it becomes evident that it is none too soon to adopt restrictive measures strong enough to allow the mackerel population to build up to a point where a reasonably large yearly crop can be taken.

PART II

SOURCE OF DATA

Whenever a commercial fisherman sells any part of his catch in California, the buyer is required by law to fill out in triplicate a special receipt on which are recorded the kinds of fish, the poundage and the price paid for each. The fisherman, the buyer and the California Division of Fish and Game each receive one copy of the receipt. The Division transfers the data from its receipt to special cards. Tabulating machines sort these cards and record the data from them in almost any desired form.[3] It is from special reports compiled by the operators of these machines that most of our boat catch figures are obtained. To back up these figures it is always necessary to do enough field work to obtain a fairly complete general knowledge of the fishery.

EFFECT OF DEMAND ON BOAT CATCH FIGURES

There are two nearly independent fisheries for mackerel in the State—for fresh fish markets and canneries. The fresh fish trade takes a small quantity of fish for local consumption. This fish must be carefully handled because mackerel bruise easily and when bruised do not keep well. The marketmen much prefer hook and line fish since the wholesale methods of the net boats effectively prevent careful handling. The canners on the other hand want large quantities of low-priced fish. The net boats meet this demand very nicely. To the packers bruised fish are not a serious consideration since they are in the can before they have had a chance to spoil.

As far back as our records go, the demand for mackerel at the fresh fish markets has been very limited—so limited in fact that the fishermen usually bring in only what they think they can sell. This limiting of catches makes a study of the landings of market boats absolutely useless for the detection of changes in abundance.

At the canneries the demand is much greater. The first large scale canning was done in 1928 and 1929, then came a three-year slump. All during these first five years the canners regulated the landings by sending the boats out on *limits*, i.e., they told each boat captain just how much they would buy from him. These limits were so low that the catch records from 1928 to 1932 are useless for the present purpose.

In 1933 all this changed. The packers had orders for canned mackerel, wanted fish badly, and took the lid off. It has been off ever

[3] Conner, Geraldine
1935. Modernizing commercial fisheries statistics. Calif. Div. Fish and Game, Fish Bull., no. 44, pp. 11-36, illus.
1937. Fish and game statistics. Calif. Fish and Game, vol. 23, no. 2, pp. 113-118.

since. A boat can sell all it can catch. From this it will be seen that the boat catches since 1933 are the only ones from which we can learn anything about abundance.

EFFECT OF PRICE

Demand and price are very closely related but should be taken up separately in this study. At the fresh fish markets, prices for one species often change by the hour and even by the minute. At the canneries, on the other hand, the price usually remains constant for an entire season. There may be penalties for small fish or poor fish, but the basic price changes very seldom. This constant price simplifies calculation immeasurably since there is no tendency for fishermen to stop work and wait for the price to rise while fishing is at its very best.

Entirely aside from the complexities caused by violently fluctuating prices, there is the effect of a steady rise or fall in price. A rise will tend to make fishermen pursue a species with more enthusiasm and to make more fishermen go after that species. Thus if the species remains equally abundant, a price rise tends to increase the total catch and, to a lesser extent, the catch of each individual boat.

The cannery price of mackerel has been steadily rising. The 1933 season opened with a price of $10 a ton. About September 1, it rose to $12.50, held this level throughout the rest of 1933 and all of 1934, jumped to $15 before the 1935 season opened, to $18 a year later, and to $21 in 1937 (Fig. 83).

There is certainly nothing in this price trend which would cause fishermen to lose interest in mackerel.

SEASON

There is a period each year when mackerel are very scarce. Hook and line boats get a few, but as a rule the cannery net boats get none at all. This period ends some time in May and fishing starts with a rush. There is good fishing until about December, then the fish disappear, sometimes gradually, sometimes more suddenly. The real period of scarcity may start any time from mid-December to March, but usually begins in late December or some time in January. Except for one difficulty we could follow a boat through the entire season. This complexity is the sardine fishery, which lasts from November 1 to March 31, a legally restricted season. Many boats go out after either sardines or mackerel and take whichever they see first. Sardines, being more abundant, are the more usual victims. This cuts down the mackerel catch in a way which is dependent on the relative abundance of the two species, and on the distance the fishermen have to go to find either. To eliminate this complexity, we have included in our calculations only those catches made between May 1 and October 31.

PRELIMINARY SELECTION OF BOATS

Our preliminary list of boats included all the cannery net boats which fished at all consistently since 1933. The net boats used in the southern California mackerel fishery fall into two distinct classes—purse seiners and lampara boats. The purse seiners are deep, broad beamed boats, 60 to 90 feet long, with carrying capacities of 70 to per-

haps 200 tons. The lampara boats are shallow, narrow craft. Most of those engaged in cannery mackerel fishing are from 45 to 55 feet long and carry 20 to 50 tons in smooth weather. The carrying capacity of a lampara boat depends to a large extent on the optimism or foolhardiness of the crew. The boats are dropping into disuse now but in former years it was nothing unusual to see a lampara boat so heavily loaded that its stern deck was 18 inches or two feet under water. In the mackerel fishery the catch of a lampara boat is often limited by its capacity, but a purse seiner is much larger and is nearly always able to carry all the crew can catch. For that reason the two types of boats were kept entirely separate in compiling the boat catch records.

Both types of boats use much the same sort of gear in fishing mackerel. A purse seine boat carries either a purse seine or a ring net; the lampara boats carry only ring nets. The differences between the two forms of gear are slight; a ring net is nothing more or less than a light weight, high speed purse seine. Both nets are set in a circle around the fish, and then closed at the bottom by a "purse line" just as a laundry bag is closed by a draw string.

CATCH PER DAY, MONTH OR SEASON?

After obtaining our list of boats, the next step was to decide whether the best unit of fishing effort was the catch per day, per month or per season. In going over the data it soon became evident that there was an increasing tendency for the boats to pass up small schools of fish and scout longer for larger schools. This resulted in a decrease in the numbers of small catches and an increase in the number of days on which nothing at all was caught. The small catches all appear in the records but the blank days do not, hence a decreasing number of small catches was bound to raise the *apparent* daily average. Obviously the average catch per day could not possibly give a true picture of what was happening in the fishery.

The use of catch per month or per season would get around any difficulty due to blank days, but each introduces some difficulties of its own. Fishing is far better in some months than in others, and only a small part of the boats fished straight through the entire season. Clearly if a boat fished only the best part of the season its *average* monthly catch would be higher than if it fished the entire season, but its *season's* total would be lower, because it would otherwise have caught something during the poor months. The obvious thing to do was to use only those boats which fished straight through the season, but unfortunately there were not enough boats which did this. Another possibility was to compare May, 1933, with every other May; June, 1933, with every other June; and so on until we wound up with six boat catch curves instead of one. These six could then be averaged. We will probably try out this method before finishing with our boat catch study of the mackerel.

The method finally decided upon for this preliminary study was to use the catch per season and to make an allowance for the time during which any boat did not fish. This allowance took into account just how good fishing was when the boat in question was not fishing,

and just how well that boat performed when it *did* fish. More about this later.

INFLUENCE OF BOATS TEMPORARILY DESERTING THE FISHERY

Since it was not possible to use catch per day as a unit of effort, it became necessary to decide just when a boat was fishing mackerel and when it was not. If a boat lands mackerel on 21 days out of a month and lands nothing else it is quite obviously fishing for mackerel. If it lands eight catches of tuna, and nothing else, it is obviously *not* fishing for mackerel. But, if it lands eight catches of mackerel, eight of tuna and three of barracuda, just what is it fishing for?

During part or all of the period from May through October, purse seine and ring net boats fish for mackerel, horse mackerel, tuna, skipjack, bonito, barracuda, white sea-bass and yellowtail.[4]

Horse mackerel is not a complicating factor. The boats take this lower priced species incidentally while fishing mackerel. In most cases a horse mackerel catch is an indication that the boat was fishing for mackerel.

Tuna and skipjack bring much higher prices than mackerel. Many purse seiners make long trips into Mexican waters for these fish alone. Such boats are easily segregated and do not have to be considered here. Frequently tuna or skipjack appear in local waters. When that happens many mackerel boats desert the fishery entirely for a week or a month and go after the more expensive species. Other mackerel boats go out with an open mind and come back with whatever they see first. Some of these go to the best tuna grounds and catch mackerel incidentally, others stick more or less closely to mackerel fishing and gather in any tuna or skipjack that happen to appear.

Bonito are in between tuna and mackerel in price, size and habits. Compared with tuna they are much more apt to be found on the mackerel grounds and to be taken in the same haul with mackerel. Unlike tuna, the bonito is seldom the cause of a large number of boats suddenly deserting the mackerel fishery.

Barracuda, white sea-bass and yellowtail[5] are fresh fish market species. Only the barracuda is abundant enough ever to cause any wholesale desertions from the mackerel fishery—and most of those desertions do not last long. Some small boat gets 5 to 10 cents per pound when the barracuda first appear, the purse seine fleet descends on the schools with a rush, the price drops to a half cent, and everybody goes home mad.

FINAL SELECTION OF BOATS

To make the final selection of boats, each season was divided into months and the monthly record of each boat examined in minute detail. If a boat spent a month in mackerel fishing, it was placed on the list for that month. If during the next month it spent too much time tuna fishing, it was left entirely off that month's list, even though it did quite a bit of mackerel fishing. If the boat brought in horse

[4] Horse mackerel, *Trachurus symmetricus;* bluefin tuna, *Thunnus thynnus;* skipjack, *Katsuwonus pelamis;* bonito, *Sarda sp.;* barracuda, *Sphyraena argentea;* white sea-bass, *Cynoscion nobilis;* yellowtail, *Seriola dorsalis.*

[5] Yellowtail may legally be canned only if it is taken south of the Mexican border.

mackerel, it was treated exactly as if it had caught mackerel. This was done because in all probability the boat was actually looking for mackerel. However, horse mackerel catches were treated as mackerel only in deciding what the boat was fishing for, *not* in calculating its seasonal boat catch. Trifling catches of unusual species were entirely disregarded—obviously they were caught while the men were looking for something else. The basis for selection or rejection was as follows:

If a boat spent a week or more fishing for anything except mackerel it was rejected for that month.

If a boat brought in mackerel regularly throughout a month, but also brought in loads of other species it was accepted only if the number of mackerel catches was at least twice that of all others combined. Otherwise, it was assumed that the boat had spent too much time looking for other species, or had deliberately gone into an area where the chances of stumbling onto an expensive species were better than on the best mackerel grounds. When mackerel and other species were landed the same day, the load was treated as a mackerel catch if it was over half mackerel.

Occasionally mackerel disappear entirely or become very scarce for a short period. Whatever a boat did during such a period was disregarded.

The criteria just given were the ones on which most boats were accepted or rejected. Other rules were established but were applied less often and need not be discussed here.

None of the rules used were set up until each catch record of every boat had been examined. The criteria were then established to give the most satisfactory and uniform treatment for all boats and all seasons. All of these rules were intended to increase the uniformity of treatment of the data; they were not intended to increase the ease of handling the data.

WEIGHTING EACH BOAT TO A FULL SEASON

When we had obtained our final list of boats it became necessary to determine just how each month compared with the other months of any one season. This was done by selecting all the boats which fished every month of that one season, adding up all the May catches, all the June catches, and so on throughout the season. Then, each month's total was converted into a percentage of the entire season's total. This method was used whenever possible. In 1935 only one lampara boat fished in every month, and in 1936 no purse seiner fished every month. In 1935, the average catch of all the lampara boats was taken for each month (arithmetic mean) and the monthly percentages were calculated from that. In 1936 the same was done for purse seiners. A comparison of the results obtained by each of the two methods in other years showed no differences of importance.

After calculating the relative values of the different months the next step was to calculate what percentage of a full season each boat fished. Assume the monthly values for one season are as follows:

	Per cent
May	7
June	15
July	18
August	10
September	20
October	30
Season	100

Let us say a boat is on the list during July, September and October. During those months it fished 18 plus 20 plus 30, or 68 per cent of the season. To weight that boat to a full season, the sum of its July, September and October catches was multiplied by $\frac{100}{68}$. Only those boats which fished over 45 per cent of the season were used.

NUMBERS OF BOATS USED IN COMPILING THE BOAT CATCH CURVES

A total of 14 lampara boats and 27 purse seiners was left in the final list from which the boat catch curves were calculated. The number used each season is shown below.

	1933	*1934*	*1935*	*1936*
Lampara boats	14	14	7	0
Purse seiners	12	10	27	17

WEIGHTING TO A BASE YEAR

Only a few of the boats used fished every season. Many new purse seiners were built between 1933 and 1936. Those boats were larger and more efficient than the older boats. If the actual catches of the boats were averaged, the entry of the new boats would tend to raise the average for the later years. To give all the boats equal weight, the seasonal catch of each was expressed as a percentage of its 1935 catch. The 1935 season was used as a base because it was the only season during which all of the purse seiners fished.

The lampara boat catches were treated in the same way except that 1934 was used as a base year. The boat catch curves were calculated by taking the average (arithmetic mean) percentage for each season.

To make the lampara boat curve comparable to the purse seine curve, it was reweighted to make 1935 equal 100 per cent.[6]

COMPARISON BETWEEN THE CATCH TRENDS OF TWO TYPES OF BOATS

The two boat catch trends are quite similar except that the lampara curve is flatter (Fig. 84). Some part of this difference is undoubtedly due to the smaller size of the lampara boats. We do not know just how much of the discrepancy is due to this one factor—perhaps only a small fraction—perhaps all. The mackerel catches of lampara boats were often limited by their capacities. The better the fishing the

[6] Theoretically this should not be done unless geometric means are used, actually results obtained by use of the two methods differed so slightly that we decided to use the better known average in this paper.

greater the limiting effect, hence there tends to be less difference between a good year and a poor year than is the case with purse seiners, since the catches of these boats are seldom limited by their carrying capacities.

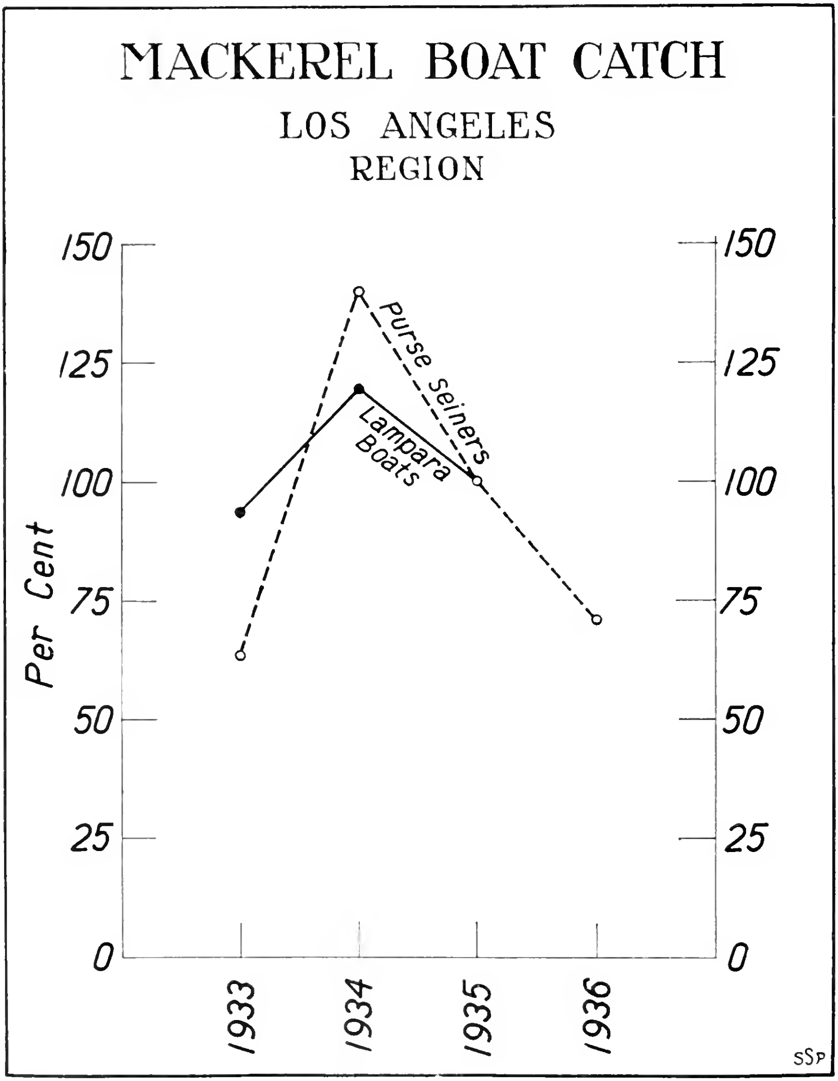

FIG. 84. Mackerel boat catch curves of purse seine and lampara boats. During 1936 no lampara boats fished consistently enough to be included in this study since many of the better lampara crews had bought or chartered purse seiners and tied up their old boats. The purse seiners are the ones more affected by changes in abundance. The reason: a purse seiner with a capacity of 100 tons may go out on a good day and catch 80 tons; on a poorer day it brings in 25 tons. A lampara boat with a capacity of 40 tons can not bring in over 40 tons no matter how good fishing is. On poorer days it may take as much as a purse seiner.

YIELD PER AREA OF THE CALIFORNIA SARDINE FISHING GROUNDS, 1935-1937[1]

By Frances N. Clark
California State Fisheries Laboratory
Division of Fish and Game

An important addition to the study of any marine fishery is information about the yield of each water area. To know the locations of the most prolific fishing grounds constitutes an economic asset to the fisherman, an invaluable aid to the administrator, and a useful contribution to the science of oceanography. To accumulate this information for the fisheries of California, the California Division of Fish and Game has divided the waters of the coast into numbered blocks. Each block comprises ten minutes of latitude and ten of longitude. The fisherman, at the time that he delivers his load, is requested to report the number of the block in which he made his catch. For the sardine fishery this report is made to an assistant warden of the Division of Fish and Game or to the weighmaster at the cannery or reduction plant where delivery is made. This method of obtaining information about the locality of catch was instituted in 1934. By the 1935-36 sardine season the system was deemed sufficiently accurate to justify its use for an analysis of the yield taken per numbered block.

The results for the 1935-36 season were reported in 1937[2] but are here repeated to make simple a comparison between the 1935-36 and 1936-37 seasons. The tons delivered during both seasons include the landings at shore plants only, and do not include deliveries made to floating reduction ships. Boats fishing for the floating ships make their catches in the same general areas as do the boats delivering to the shore plants but our detailed information about the locations of individual catches covers only deliveries made on shore.

The tons taken per numbered block are shown in figure 85 for the 1935-36 season and in figure 86 for 1936-37. As a whole the two seasons are similar, but they differ in minor details. In the San Francisco-Monterey area the deliveries were made either to San Francisco Bay ports or to the port of Monterey. In this area more tons were taken in the blocks adjacent to Pigeon Point, Point Montara and Point Reyes in 1936-37 than in 1935-36. This resulted in an increase in the total tons taken during 1936-37 in the entire San Francisco-Monterey area as the tonnages caught in other parts of the area changed but little between the two seasons.

In southern California, where our information comprises catches delivered to the ports of San Pedro and San Diego, the situation is somewhat different. In 1935-36 the fishery showed a strong tendency

---

[1] Submitted for publication, August, 1937. Credit for the drawing of figures 85 and 86 goes to Mr. Stevan S. Pavitt, of the Works Progress Administration, Project 6915-S, who also compiled the data for the 1936-1937 season from the detailed reports of the California Division of Fish and Game.

[2] Calif. Div. Fish and Game, Fish Bull., no. 48, 11 pp., 5 figs.

to concentrate in the blocks adjacent to Point Vicente, whereas in 1936-37 fishing was less concentrated and the greatest tonnages were taken in the block bordering on Newport. This represents an actual change in the location of the major fishing grounds. The total tonnage taken in the San Pedro-San Diego area was less in 1936-37 than in 1935-36.

Up to the present time no fishing for sardine canning and reduction plants has been carried on between Point Sur and Point Conception. This should not be construed, however, as an indication that sardines are not to be found in this region. This area lies too far distant to be profitably fished by boats operating out of the ports of Monterey or San Pedro. Also lack of suitable harbors and adequate labor and shipping facilities have prevented the establishment of large fishing centers along this portion of the coast. These factors and not the scarcity of fish or unfavorable fishing conditions apparently account for the absence of a sardine fishery in this area.

Along the entire coast there are very few records of catches made in waters deeper than 500 fathoms. In central California the fishing grounds extend northward and southward along the coast but not to great distances from shore. Near San Francisco the 500-fathom line lies well off shore and here the fishing grounds extend seaward in a corresponding manner. Southward toward Monterey Bay, as the 500-fathom line draws closer to land, the fishing localities are also limited to a similarly narrowing belt along the shore.

In southern California the ocean contours are more complex, but in this area also the fishing grounds are very largely confined to waters of less than 500 fathoms. Here comparatively shallow water extends out some distance beyond the Channel Islands, with the exception of a deep valley which runs southeast from Santa Cruz Island. Between San Nicolas and Santa Barbara islands it narrows and southeast of Santa Barbara Island divides. The two branches continue southeastward on either side of San Clemente Island. The fishermen cruise across this valley and fish beyond it but almost no catches are reported from squares lying wholly within the valley. This limitation of the sardine fishing grounds to comparatively shallow waters probably results from a corresponding distribution of the sardine population. Presumably sardine schools are not found over deeper waters, perhaps because food is more plentiful in the shallower regions. The complete explanation of this phenomenon, however, must await more detailed oceanographic investigations of the waters along the California coast.

To trace the history of the development of the California sardine fishing grounds is not possible from two seasons' data, but fortunately the California State Fisheries Laboratory has additional information about the localities where sardines have been caught in past seasons. Since 1919, members of the laboratory staff have questioned a limited number of fishermen each week and thus learned where the sardine fishing has been carried on year by year.

These records,[3] collected for nineteen years, all indicate that sardine fishing has occurred only within shallow waters. In the early history of the industry fishing was confined to waters very close to the

[3] Calif. Div. Fish and Game: Fish Bull., no. 11, pp. 128-130; Fish. Bull., no. 25, pp. 1-44; Fish Bull., no. 19, pp. 5-9; Fish Bull., no. 48, pp. 1-11.

ports of Monterey, San Pedro and San Diego. As the industry grew and the demand for fish increased, larger boats were built and the fishermen cruised over wider areas. From Monterey the expansion was chiefly northward, with only a small number of boats occasionally cruising to the south. With the development of canning and reduction plants on San Francisco Bay this northward expansion was greatly augmented. The fact that this expansion could take place is probably dependent on the wide expanse of shallow water off San Francisco in contrast to a restricted area of shallow water to the south of Monterey. The trend of this expansion has been manifest for more than a decade and the data here presented graphically show the present culmination of this movement.

In southern California, as the industry enlarged, the boats have extended their operations around all the Channel Islands, up the coast as far as Point Conception and southward to Los Coronados Islands just below the international boundary. San Pedro boats occasionally fish as far south as San Diego, but as a rule not much south of Oceanside. The San Diego boats fish from Oceanside southward to Los Coronados Islands. As in central California, figures 85 and 86 indicate the present extension of the southern California fishing grounds. During the past decade no new fishing ports have developed in southern California and as a consequence the location of the fishing grounds has changed but little.

The future of the California sardine fishery remains in doubt. Present indications are that the demand exceeds the supply. To meet this problem in other fisheries, fishing grounds have been extended. For the California sardine, however, the fishing localities appear to be limited to relatively shallow waters most of which are now being exploited from Point Arena south to the Mexican border. In addition all available information indicates that the sardine population moves freely from locality to locality and the development of new grounds would merely draw from the same population as does the present fishery. An increase in the fishery for the California sardine does not, therefore, seem probable.

To avoid confusion the numbers of the blocks are not shown on the maps of figu s 85 and 86. For the benefit of those who wish to refer to block numbers, a small key map is inserted on figure 85. This shows the numbers of the blocks and the names of the Channel Islands.

4—49659

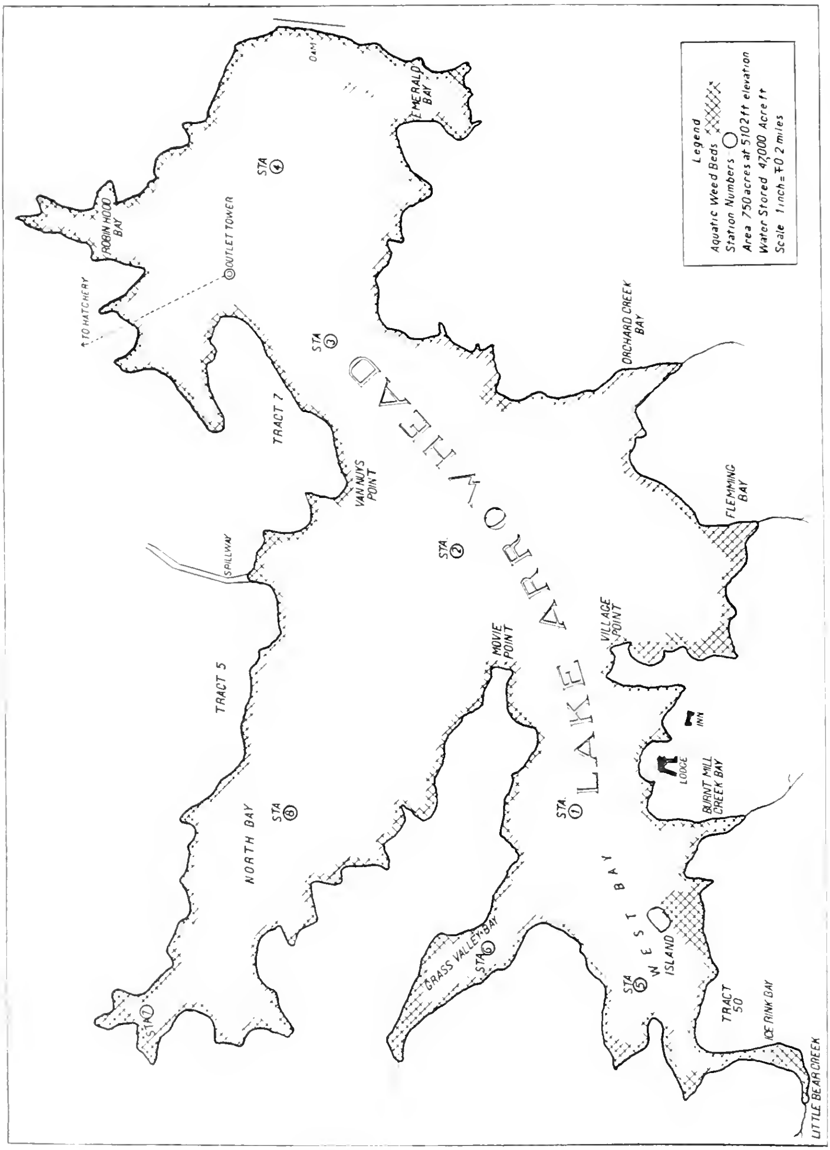

FIG. 87. Map of Lake Arrowhead showing aquatic weed bed areas and location of stations worked.

A BIOLOGICAL SURVEY OF LAKE ARROWHEAD, CALIFORNIA[1]

By P. R. NEEDHAM, PH.D.
Associate Aquatic Biologist,
U. S. Bureau of Fisheries

INTRODUCTION

In order to obtain the necessary facts upon which to base definite recommendations for the management and stocking of Lake Arrowhead, a biological survey was made of this lake by the writer from November 18 to November 26, 1935, at the request of J. B. Van Nuys, President of the Arrowhead Lake Corporation.[2] This length of time permitted securing adequate samples of the fish population, quantitative and qualitative samples of the available food supply, chemical analyses of the water, and other related information of importance.

Field equipment used consisted of scales for weighing food samples, counting pans, Ekman dredge, field chemical kit, thermometers, Kemmerer water sampler, scale books, gill nets, minnow seines, and other items of lesser importance. Standard lake survey methods were used throughout with one exception, viz.: all bottom food organisms taken in each bottom sample with the Ekman dredge were weighed as well as counted to obtain weight of food per unit area in addition to numbers. By weighing all food organisms taken it has been possible to evaluate the standing crop of available food in pounds per acre of bottom area.

GENERAL FEATURES OF LAKE

Lake Arrowhead lies at an elevation of approximately 5100 feet in the San Bernardino Mountains, less than 100 miles from Los Angeles. It is a typical, cold water, high mountain lake, artificial in point of origin, and was originally intended for irrigation purposes until taken over by the Arrowhead Lake Corporation and devoted entirely to recreational uses. All timber was removed prior to flooding the area and the shoreline therefore lacks drowned timber characteristic of many artificial lakes. Only streams were present originally in the drainage area and as a result several typical lake fish food organisms are lacking that might be expected to be present if the lake were naturally formed and of greater age. The maximum depth is 150 feet, with approximately an average annual drop in level of between three and five feet due to evaporation and domestic use of the

---

[1] Published by permission of the U. S. Commissioner of Fisheries and the Lake Arrowhead Corporation. Submitted for publication, August, 1937.

[2] Equipment for the survey was loaned by the U. S. Bureau of Fisheries and the field work was carried on by the writer while on annual leave. Mr. Francis Sumner of Santa Barbara assisted in the field work. The Arrowhead Lake Corporation supplied living quarters and meals, boats, outboard motor, and ample field headquarters for the work. My thanks are due Mr. J. B. Van Nuys, President of the Arrowhead Lake Corporation, Mr. Briggs and Mr. Canfield of the administrative staff, Mr. Morris Ellinger, Engineer, and Captain Tuttle and Mr. Probst, boatmen, for much assistance supplied in the course of the field work on the lake.

water. The margin of the lake exposed during periods of low water varies from about 7 to 30 feet depending upon the gradient of the bottom at various points. Unlike most high Sierra lakes, aquatic plants are fairly abundant. The shoreline is fringed by a belt of the reddish-brown water weed, *Ceratophyllum demersum*, except where it has been cleaned away for boating or swimming purposes. Two other aquatic weeds occur in lesser abundance in deeper waters.

Lake Arrowhead, lying as it does close to populous cities in southern California, is fished very intensively. While it is not open to the general public, persons renting boats are permitted to fish. The Lake Arrowhead Corporation owns and manages the lake, and for some years operated a private hatchery in which trout were reared for planting in the lake. State fishing laws relating to seasonal and bag limits are enforced and persons fishing the lake must possess a State angling license.

Over a thousand pleasure boats [3] of all kinds are used on the lake in the summer time, and it is quite remarkable that the fishing has not been completely decimated. Over four hundred summer homes have been built about the lake and the seasonal residents plus transient vacationists in search of sport fishing have put a severe drain on the lake. Such intensity of angling, if any sport fishing whatsoever is to be maintained, calls for a most carefully planned and efficiently executed stocking and management program.

Table 1 shows the points on the lake that were established as stations for obtaining survey data. This was done merely for the purpose of quickly and easily locating points of work on the lake. In addition to the eight stations mentioned in this table, two other areas were worked for analyses of shoal water conditions, viz., the south side of Movie Point and the upper end of Grass Valley Bay. Additional general collections were made both by hand and with the Ekman dredge in all bays at numerous points along the shoreline.

TABLE 1

List of Stations where Survey Data were Obtained in Lake Arrowhead

Station No.	Location	Depth in feet	Type of bottom	Aquatic plants present	Number of bottom samples taken*
1	Center of West Bay	42-45	Silt	None	4
2	Center of lake between Van Nuys and Village points	101-108	Silt	None	4
3	Center of lake southeast of Tract 7	117-125	Silt	None	4
4	Deepest part of lake opposite dam	103-150	Silt	None	4
5	Center of bay northwest of the island	14- 28	Silt and plant remains	*Nitella* in scattered patches	4
6	Center of Grass Valley Bay	20- 40	Plant remains	Algae	4
7	Upper end of North Bay	27- 55	Silt and plant remains	*Nitella* in scatered patches	4
8	Center of North Bay opposite Tract 5	65- 83	Silt	None	2

* In addition to the bottom food samples listed here, six were obtained in water less than ten feet deep on the south side of Movie Pt. and in the upper end of Grass Valley Bay as noted in Table 3.

Temperatures prevailing in Arrowhead Lake the year round are most suited to rainbow trout as shown by the annual records kept by

[3] Information supplied by Captain Tuttle, in charge of boats for the Arrowhead Lake Corporation.

Morris Ellinger, Engineer for Lake Arrowhead Corporation. The following list gives an approximation of the mean monthly temperatures:

APPROXIMATE MEAN MONTHLY TEMPERATURES FOR LAKE ARROWHEAD

January	43° F.	July	68° F.
February	41°	August	70°
March	40°	September	69°
April	48°	October	61°
May	56°	November	49°
June	65°	December	47°

From the above list it is evident that good growing temperatures for trout exist for eight months of the year, from April to November, inclusive. Naturally the mean of any given month will vary from year to year depending upon seasonal conditions, but in so far as the general average temperatures of the lake waters are concerned, rapid growth could be expected over the above named months. At no season do Ellinger's figures show temperatures above the range of tolerance for rainbow trout. Monthly temperatures show the water to be too cold for good development of Loch Leven or brown trout, and too warm for the best results with eastern brook trout. Another strong argument against the planting of these species is that they are fall spawners. At this season the tributary streams are dry or practically so, which would prevent any spawning migrations of these species into the streams. Rainbows are spring spawners, and ample run-off from the tributaries at this season makes it possible to trap breeding fish migrating upstream and to take eggs for rearing in hatcheries. For the above reasons, Loch Leven or brown trout and eastern brook trout should not be planted in Lake Arrowhead.

CHEMICAL ANALYSES OF LAKE WATER

In table 2 is submitted the results of chemical analyses of Lake Arrowhead waters taken at various stations and at various depths. Figure 88 gives the oxygen and temperature curves as taken at station 4 in the deepest part of the lake. Examination of both figure 88 and table 2 indicate that oxygen was deficient for trout below a depth of approximately 100 feet. Trout usually require between four and five parts per million and the amounts shown below the 100-foot level would be insufficient. This by no means is an unusual condition in lakes generally. It merely restricts trout to the upper layers where the oxygen supply is more abundant. Deep water lakes like Lake Arrowhead often show deficient oxygen in their lower waters due to stagnation periods in summer and in winter. Analysis of the oxygen supply of the water at the 80-foot level next to the outlet tower where water supplying the hatchery is taken off, showed 8.32 parts per million, which is ample for hatchery use. Oxygen analyses in Grass Valley Bay and other shallow water areas were shown to be ample in all respects.

Slightly alkaline conditions existed in the upper layers of the lake surface waters showing a pH of 7.7, and at the 50-foot level a pH of 7.5. Deficiency in oxygen with proportional high increase in

CO_2 reduced the pH to an acid condition below the 100-foot level where the pH was found to be 6.8.

Methyl orange alkalinity, i.e., the determination of alkalinity in terms of calcium carbonate, were made because of the importance of this factor in the production of aquatic fish foods. Waters relatively rich in calcium carbonate are known to produce more fish food than

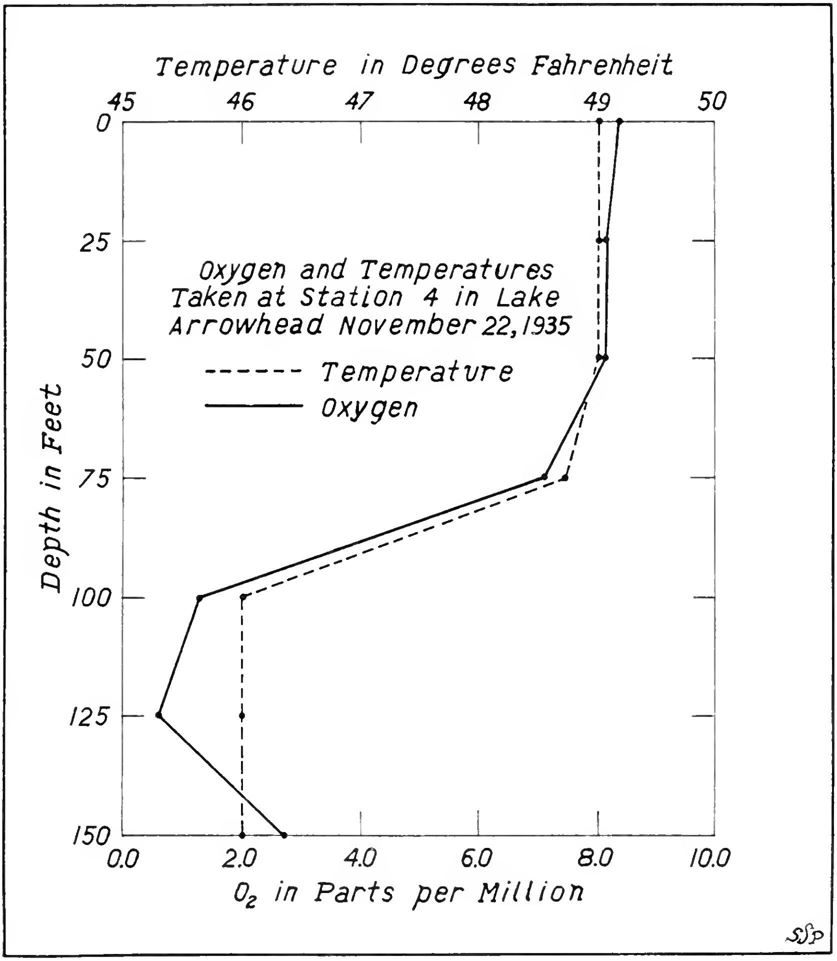

FIG. 88. Oxygen and temperature chart for Lake Arrowhead.

waters deficient in this salt. Two such determinations made of the surface and bottom waters at station 4 showed 23 and 24 parts per million, respectively, of calcium carbonate. These amounts are more than is usually found in high Sierra lakes and is reflected in existing food conditions.

FOOD SUPPLY OF LAKE ARROWHEAD

There are four types of food available to trout in Lake Arrowhead: bottom foods, plankton, drift food, and the young of all fishes present

in the lake. Bottom dwelling forms consist largely of midge larvae and pupae, *Corethra* (*Chaoboris*) larvae, with a scattering of damsel fly nymphs occurring in shoal areas. Plankton consists of minute plants and animals that are free-swimming, short-lived forms, and includes a great variety of crustaceans, protozoans, algae and rotifers. The crustaceans are the most important group of plankton in so far as the food of trout in the lake is concerned. Large numbers of water fleas, *Daphnia*, belonging to this group were taken from the stomachs of trout caught in gill nets. Copepods and ostracods are likewise important as food and also belong to the Crustacea. Drift food consists largely of terrestrial insects that are blown into the water from the land during the warmer months of the year. This type of food furnishes a very considerable portion of the food of trout in mountain lakes in the summer time, as shown by stomach examinations.

TABLE 2

Chemical Data Taken in Lake Arrowhead, November 22, 1935

Station No. or location	Depth in feet	Temp. °F.	O_2 ppm.	pH	M.O. Alk. in ppm. $CaCO_3$
4	Surface	49.0	8.32	7.7	23
	25	49.0	8.08		
	50	49.0	8.15	7.5	
	75	48.7	7.06		
	100	46.0	1.26	6.8	
	125	46.0	0.63		
	150-B*	46.0	2.66	6.8	24
1	Surface	49.0	8.64		
	56-B*	49.0	7.38		
2	107-B*	53.0	0.54		
Outlet tower	80	48.5	8.32		
Grass Valley Bay	Surface	48.5	7.06		
Grass Valley Bay	10-B*	50.0	8.08		

* Indicates the bottom at this depth.

It is possible to measure accurately the amounts of bottom foods present in lakes and this was done in the survey of Lake Arrowhead. It is not possible, however, to measure accurately the amounts of food supplied by the plankton, drift, or young of fishes. Only rough estimates of the amounts of these foods were made and applied in the formulation of the stocking policy in relation to the food supply.

Bottom Foods

Thirty-six quantitative bottom food samples were taken in the lake with the Ekman dredge. This apparatus secures samples covering 36 square inches of bottom or one-quarter of a square foot. Both numbers and weight of food per square foot, per acre, or by depth zones have been determined by calculations from the original data determined from each sample or averages of same.

TABLE 3

Tabulation of Bottom Foods. Samples Taken With Ekman Dredge in Lake Arrowhead Survey

Station no.	Date	Sample No.	Depth in feet	Wet wt. of food in grams	Number of organisms: Midge larvae	*Corethra* larvae	Damsel fly nymphs
1	11/20/35	1	45	.065	12	5	0
		2	45	.04	7	10	0
		3	45	.05	9	17	0
		4	42	.05	9	12	0
2	11/20/35	1	101	+	0	2	0
		2	101	+	0	2	0
		3	102	+	0	1	0
		4	108	+	*0	*0	*0
3	11/20/35	1	117	+	0	0	0
		2	117	+	0	0	0
		3	125	+	0	0	0
		4	120	+	0	0	0
4	11/20/35	1	125	+	0	0	0
		2	103	+	0	0	0
		3	141	+	0	0	0
		4	150	+	0	0	0
5	11/21/35	1	14	.125	19	8	0
		2	15	.015	2	2	0
		3	22	.01	3	2	0
		4	28	.06	3	29	0
6	11/21/35	1	20	.005	6	0	0
		2	20	.013	5	5	0
		3	32	.025	12	1	0
		4	40	.13	50	44	0
7	11/24/35	1	27	.055	23	2	0
		2	37	.02	7	0	0
		3	43	.065	21	1	0
		4	55	.005	2	0	0
8	11/24/35	1	65	.01	1	0	0
		2	83	.01	1	0	0
Shoal samples** where taken							
South side Movie Pt.		1	4	.05	20	0	17
Near shore		2	4	.03	53	0	5
Middle of weed bed		3	5	.042	20	0	4
Submerged weed zone		4	10	.015	16	0	6
Grass Valley Bay, in weed zone		5	10	.010	10	2	0
Grass Valley Bay		6	2	.025	12	0	16

* Only bristle worms (oligochaetes) that are not eaten by trout were taken in most of the deep water bottom samples, and a "plus" (+) has been used to indicate their presence where other true food organisms were lacking.
** Taken November 25, 1935.

TABLE 4

Weight of Bottom Foods Present in Lake Arrowhead by Depth Zones

Depth zone	Number of samples	Wet weight of food*		
		In grams per Ekman sample	In grams per sq. ft	In pounds of food per acre
0- 10 ft.	6	.0286	.1144	11
11- 20 ft.	4	.0395	.1580	15
21- 50 ft.	11	.0518	.2072	20
51-100 ft.	3	.0083	.0332	3
100 ft. up	12	+	+	+

*Wet weight of food was found by sorting organisms out of each sample, drying them for a standard time of one minute on blotting paper, and weighing on a sensitive scale.

TABLE 5

Numbers of Fish Food Organisms Taken in Bottom Samples by Depth Zones

Depth zone	Number samples	Food organisms			
		Average number per sq. ft.	Number per sq. acre	Dominant forms	Miscellaneous
0- 10 ft.	6	120.64	5,255,078	Midge larvae	Damsel fly nymphs
11- 20 ft.	4	47.0	2,047,320	Midge larvae	None
21- 50 ft.	11	101.44	4,418,726	Midge larvae	None
51-100 ft.	3	5.33	232,174	Midge larvae	None
101 ft. up	12	+	+	Bristle worms	None

TABLE 6

Total Standing Crop of Available Bottom Foods in Pounds per Acre by Depth Zones, Lake Arrowhead, November, 1935

Depth zone	Acres*	Lbs. per acre	Total pounds of bottom foods
0- 10 ft.	70	11	770
11- 20 ft.	70	15	1,050
21- 50 ft.	210	20	4,200
50-100 ft.	280	3	840
100 ft. up	120	+	+
Totals	750		6,860
Average			9.14 lbs. per acre

* Based on level of lake, 5,102 ft., January 30, 1935.

Weight of Bottom Foods

In table 3, will be found the complete data on each sample taken. In table 4, the weights have been averaged and calculated to show wet weight of food by depth zones. Here it is shown that the most food by weight was available in the 21-foot to 50-foot zone which averaged 20 pounds per acre. The 11-foot to 20-foot zone showed 15 pounds per acre, the second highest weight, while the 0-foot to 10-foot and 51-foot to 100-foot zones averaged 11 pounds and 3 pounds per acre, respectively. Bottom samples taken in water over 100 feet deep were entirely lacking in trout foods. Lack of oxygen in the deeper layers,

as shown in table 2, is undoubtedly a major cause of the paucity of food organisms in this zone. Bristle worms (oligochaetes) were abundant in all samples taken in water over 100 feet deep. These organisms, while forming an important link in the ecology of lake waters, nevertheless are never eaten by trout, and no counts or weights of these animals were made from the bottom samples.

Numbers of Bottom Foods

In table 5 is shown the numbers of organisms calculated for each depth zone to numbers per square foot and numbers per square acre. Here it is evident that, by numbers at least, the shallow water 0-foot to 10-foot zone was richest, averaging over 120 organisms per square foot. The 21-foot to 50-foot zone was next, showing over 100 per square foot. The 11-foot to 20-foot zone was third, averaging 47 per square foot, while the 51-foot to 100-foot zone gave a figure only slightly over 5 organisms per square foot.

As noted previously the dominant bottom foods occurring in the samples were midge larvae and pupae (Chironomidae), phantom midge larvae (*Corethra*), and damsel fly nymphs (Odonata). No scuds, shrimp, beetles, water boatmen or other aquatic Hemiptera, caddice fly larvae or pupae, mayfly nymphs, or other forms, that are often found in lakes, were taken in the quantitative samples or in general hand collecting. Empty larval caddice fly cases were found in the trash from bottom samples, a fact that indicates that the members of this group are present, but scarce, in the lake.

By numbers, midge larvae and pupae formed 57 per cent and phantom midge larvae 43 per cent of total bottom organisms in water over 10 feet deep. Both the members of these groups (families Chironomidae and Culicidae) belong to the order Diptera or true flies and hence it may be said that the bulk of the food in the lake consists of "fly" food. In shallow water less than 10 feet deep, midge larvae and pupae formed 72.4 per cent of the total numbers and phantom midge larvae and damsel fly nymphs formed 1.1 per cent and 25.6 per cent, respectively, of total numbers of potential available foods.

Weight Compared to Number of Food Organisms Present

It is evident in table 5, that in so far as numbers are concerned the 0-foot to 10-foot zone was richest in food. On the other hand, in table 4, it has been shown that by weight the 21-foot to 50-foot zone was richest, our measure showing a standing crop of 20 pounds per acre available. It is a well known fact that the shoal areas of lakes produce the largest amounts of food for fish. This is generally true in most lakes and from the standpoint of numbers, holds true for Lake Arrowhead as well. However, total weight or bulk of food is far more important than numbers of food organisms from a fishcultural standpoint. Using this criterion then, we would say, on a basis of pounds of food per acre, the 21-foot to 50-foot zone offered the largest amount of potential food even though the 0-foot to 10-foot zone offered greater numbers of food organisms. The discrepancy between weights and numbers is more apparent than real and the reason obviously lies in the bulk or weight of the individual organisms taken in each zone. The 0-foot to 10-foot zone averaged 120 per square foot (table 5) but

these were mostly small in size, giving a weight of food of only 11 pounds per acre. The 21-foot to 50-foot zone, on the other hand, averaged only 101 per square foot in numbers but gave a total weight of 20 pounds of food per acre due to the presence of many larger and heavier organisms.

Total Standing Crop of Bottom Foods

In order to arrive at a measure of the total standing crop of available bottom foods, it was necessary to determine the approximate acreage in each depth zone. Ellinger very kindly supplied the writer with a curve giving area in acres plotted against elevations of the lake basin, from which these were secured.

In table 6, these data are shown along with the total amounts of food present in each zone. This table represents the end point of the aims in sampling bottom fauna of Lake Arrowhead. Here it is shown that a total of 6,860 pounds of food were available in the lake as a whole at the time the survey was made, or an average of 9.14 pounds per acre. This average per acre compared to other high mountain lakes in California is only *fair*. Food conditions as a whole in the lake, covering all aspects, may also only be said to be fair. As noted below, it may be possible to greatly improve the food supply by the introduction of food organisms not now present in the lake.

It should be stated that the above total weight of food is a measure of the standing crops only as found at the season of the year the survey was made. Had the survey been made in July or August undoubtedly more seasonal land and aquatic foods such as beetles, bugs, and other organisms would have been found that would have shown somewhat more abundant food supplies available in pounds per acre. Further, the above figures give no indication of the rate of replacement or "turn-over" of bottom foods. It is well known that organisms such as midges produce several generations in a single growing season and this fact too must be kept in mind in calculating total foods against productivity in trout.

Plankton

Free-swimming plankton organisms were collected by means of a fine-meshed net drawn behind a boat. These plants and animals are to lakes what green vegetation is to the land—the basic source of all food.

The dominant form collected was *Mougeotia*, a filamentous green alga. So abundant was this in the lake at the time the survey was made, the water was tinged a definite green. The transparency of the water was likewise materially reduced. In addition to *Mougeotia*, the desmid, *Staurastrum*, was fairly common as well as the water fleas *Bosmina* and *Daphnia*. The three flagellates, *Volvox*, *Ceratium*, and *Eudorina* occurred occasionally as did a few rotifers and protozoans. The plankton found may be said to be typical of lakes in general, and furnishes considerable amounts of food annually to trout. While the organisms contained in the plankton are small, they make up in numbers what they lack in size. Hundreds of the water fleas, *Daphnia*, were taken from the stomachs of trout caught in a gill net set made in Emerald Bay, as noted below.

AQUATIC PLANT BEDS

As noted in the introduction, three types of aquatic plants are fairly abundant in Lake Arrowhead. *Ceratophyllum demersum* is dominant. It forms extensive beds in the shallow, upper portions of most of the bays and is particularly abundant in Grass Valley, Ice Rink, Burnt Mill, and Flemming bays. It also forms a marginal fringe along most of the shore line in water from two to eight feet deep.

The other two plants that occur in lesser abundance in deeper water are the pond weed, *Potamogeton crispus*, and the bottom dwelling alga, *Nitella*. The former is commonly found in water between ten and fifteen feet deep, and the latter prefers deeper water from fifteen to thirty feet in depth. *Nitella* was particularly abundant off Van Nuys Point and in Burnt Mill Creek Bay.

All the above plants are of the greatest value in assisting trout production in Lake Arrowhead. The *Ceratophyllum* particularly furnishes much food for the aquatic invertebrate fauna that serve as direct food for small trout, and the shelter afforded young, newly planted fry or fingerlings in the interlacing stems and leaves must prevent a considerable amount of cannibalism by the larger fish in search of food. Some shelter and food are supplied likewise by the *Potamogeton* and *Nitella*, but in considerably smaller amounts due to their lesser abundance in the lake.

FISHES PRESENT

The following species of fish were taken by means of gill nets in the course of the survey: rainbow trout, *Salmo gairdnerii;* square-tail catfish, *Ameiurus nebulosus;* and the green sunfish, *Apomotis cyanellus*. No Loch Leven trout or goldfish were taken though both are said to be present. A Loch Leven trout, weighing 16 pounds 9 ounces, was caught in the lake one summer a few years ago.

All three species taken in the gill net sets may be considered as game fishes. Catfish and sunfish readily take baits offered by "still" fishermen, as do the smaller rainbow trout. Most of the larger trout are taken on trolling rigs. The green sunfish is the only spiny-rayed fish present in the lake and is normally an inhabitant of warm waters, being commonly found associated with bass, perch, bluegill sunfish, and other species. It is the opinion of the writer that green sunfish are not at present harmful to the balance of fishes in Lake Arrowhead, but it is important that no other spiny-rayed fishes, such as bass or perch, should under any conditions be planted in the lake. Very definite harm would result to the trout fishing. Doubtless sunfish offer young trout considerable competition for food though it is also probably true that young sunfish are eaten in considerable numbers by adult trout, though none were found in the stomachs of the twenty-eight trout examined.

In eastern waters catfish are found commonly associated with eastern brook trout under natural conditions. Since catfish eat different foods than trout, in Lake Arrowhead these fish should not seriously hamper the development of good trout fishing.

Abundance of Fish

In table 7 are shown the catches taken in three gill net sets fished a total of 45 hours. A total of 28 rainbow trout, 16 sunfish, and 7 catfish were caught. It may be said from these figures that the trout population of the lake is low, as this amount of gill net fishing in lakes having abundant fish population will catch much greater numbers of fish in considerably less time. The total catch of all species was 0.5 fish per hour in set No. 1, 0.75 fish per hour in set No. 2, and 1.3 fish per hour in set No. 3 (table 7). The average over the three sets and points fished was 0.86 fish per hour without adjusting for either variations in type of nets used or localities fished.

TABLE 7

Fish Taken in Gill Net Sets in Lake Arrowhead

Location of set	Number, mesh and size of net	Number fish caught			Total hours fished	Set No.	Date
		Rainbow	Catfish	Sunfish			
Ice Rink Bay opposite lots 5, 6 and 7, Tract 50.	1-net, 100 ft. long, 5 ft. deep, 5 sizes of mesh.	2	0	5	14	1	Nov. 20-21, 1935
Off point, between Grass Valley and West bays	2-nets totalling 220 ft. in length by 5 ft. deep each, of five sizes of mesh.	9	1	11	28 (both nets)	2	Nov. 21-22, 1935
Off east shore of Emerald Bay	1-net, 125 ft. long by 6 ft. deep; 1″ sq. mesh only.	17	6	0	17	3	Nov. 25-26, 1935
Totals		28	7	16	59		

If the relative proportion of each species as taken in the gill nets is used as an index of the relative abundance of each in the lake itself, rainbow trout form 55 per cent of the population, catfish 7 per cent, and green sunfish 31 per cent, respectively. Since the gill nets were set at depths up to only about 60 feet, these proportions could only be said therefore to apply to the shallow water portions of the lake. However, since low oxygen was found below the 100-foot depth, which would tend to drive the fish into the upper layers, the chances are that the net catches represent a fair index of the relative abundance of each species.

Size of Fish

The 28 rainbow trout taken (table 8) averaged 9.8 inches in length. The largest taken was a female 20.25 inches long, weighing 3.92 pounds. The smallest taken was a male 7 inches in length. The data were statistically treated and the probable error of the average length was found to be ± 0.31 inch indicating that a like sample taken under the same conditions would not vary in the average length more than 0.31 inch above or below the average of the 28 trout taken.

The average length of the catfish and sunfish taken was 7.4 inches and 4.3 inches, respectively.

The average weight of the rainbow trout was approximately half a pound (0.48 pound, table 8). Fish of this size offer good sport

fishing with flies and are the proper pan size. A large population of medium sized trout for a large number of anglers is far preferable to a light population of large sized trout that would offer sport to only a few anglers. It should be the aim of the stocking policy to supply large numbers of trout running between one-quarter and half a pound.

TABLE 8

Data on Rainbow Trout Taken in Gill Net Catches

Gill net set no.	Total length in inches	Weight in lbs.	Sex	Condition factor
1	20.25	3.9200	Female	47.20
2	14.0	.9531	Female	34.73
1	13.5	.8281	Male	33.65
2	10.5	.4843	Male	41.83
3	10.5	.3750	Female	32.39
3	10.12	.4453	Female	42.90
3	10.0	.3828	Female	38.28
3	9.87	.3828	Female	39.75
3	9.75	.3906	Female	42.14
3	9.75	.4062	Female	43.82
2	9.62	.2968	Female	33.28
3	9.37	.3203	Female	38.87
3	9.37	.3437	Female	41.66
3	9.25	.3281	Female	41.45
3	9.12	.2968	Female	39.06
3	9.0	.2812	Male	38.57
3	9.0	.3671	Male	50.35
3	8.87	.2734	Female	39.11
3	8.87	.2656	Female	38.00
2	8.75	.2656	Female	39.64
3	8.75	.2578	Female	38.48
2	8.75	.2812	Female	41.97
2	8.75	.2656	Male	39.64
3	8.62	.2421	Female	37.73
2	8.62	.2656	Female	41.40
2	8.12	.2187	Female	40.77
3	8.0	.2343	Male	45.76
2	7.0	.1562	Male	45.53
Averages	9.8	0.48		40.28

Condition of Trout

The "condition factor" is commonly used by fish culturists as a measure of plumpness in relation to length. Many lakes overstocked and underfished in relation to the available food supply will often produce long, big headed emaciated trout having very low condition factors around 25. Such fish are of little sport or food value. The condition factors of fish in excellent condition will run between 39 and 45. A factor of 42 is considered average. Condition factors are determined by the following formula:

$$\frac{\text{Weight in pounds}}{(\text{length in inches})^3} \times 100{,}000$$

In table 8 it is shown that the average condition factor for the 28 rainbows was 40.28. The lowest obtained on any single fish was 33.28 and the highest was 50.35. The largest fish taken was a female weighing 3.92 lbs. Her condition factor was 47.20 and undoubtedly, since she contained many developing eggs, the additional weight of same contributed materially to produce a high factor. In brief, the present trout population of Lake Arrowhead is in excellent condition. Internal

examination showed much fat in the body cavity. The fish are small headed, deep bodied and in all respects in first class condition. It is quite evident that the lake at present is not overstocked in relation to the food supply.

Age of Trout as Determined from Scale Readings

Scales were taken from all trout caught in gill nets, mounted on slides, and examined microscopically. The bulk of the fish taken were found to be in their second and third years. Only a single fish had spawned once as shown by a spawning "check" on its scales. This was the largest fish taken, a 3.92 pound female apparently four years old, and it was evident from the eggs she contained that she would have spawned again in the spring of 1936 had she not been caught. A few males and females of those taken would have spawned in the spring of 1936 as shown by the condition of the gonads. However, it was evident with the fish examined, that the bulk of them would spawn for the first time at the end of their third year. Other work on rainbow trout in high mountain lakes in California has shown that a few of the larger rainbows will spawn in their third year, though it is generally believed that the greater proportion of them perform this function for the first time in their fourth year. This fact should be kept in mind when protective measures are adopted for the lake, so that a sufficient escapement from anglers may be assured that will reach breeding age to provide the necessary egg supplies for restocking the lake.

Scales of roughly half of the fish showed first year growth typical of hatchery fish and were evidently the result of plants made from hatcheries in previous years. Several scales were doubtful reading in this respect and it could not be determined for certain whether they were the result of hatchery or natural propagation. Many showed definite stream growth on their scales. Evidently some spawning fish escaped the traps to spawn naturally in the tributary streams, the resultant young surviving to reach the lake to continue their growth. Last August numerous naturally spawned young rainbows were seen in the deeper pools of Grass Valley and Little Bear creeks. Since all the tributary streams of Lake Arrowhead dry up or become very low in late summer and fall, it is far better to take the eggs artificially than to permit natural spawning where the chances of survival of the resulting young are low.

Trout Stomach Examinations

The stomachs of all trout taken in gill nets were examined and the food content recorded.

Fish taken in gill net set No. 3 had consumed more water fleas, *Daphnia*, than any other food. These free-swimming crustaceans were absent from the stomachs of the nine rainbows taken in set No. 2. The latter fish contained midge larvae and pupae as the dominant food. In contrast, the seventeen rainbows taken in set No. 3 contained but few midge larvae and pupae, over 98 per cent being water fleas as noted above. A few phantom midge larvae, *Corethra*, were found in a few stomachs though the total number eaten was low. Young fishes were

absent from all stomachs. Damsel fly nymphs were likewise lacking in the stomachs.

A few terrestrial ants and beetles were found in a number of stomachs; organisms that had fallen into the water accidentally. Land foods blown or falling into lake waters in the warmer months of the year contribute very considerable amounts of food to trout and other fishes. During June, July, and August as high as 50 per cent of the diet may be supplied from this source. Small bits of the aquatic pond weeds, *Potamogeton crispus* and *Ceratophyllum demersum,* occurred in a few of the stomachs.

In summary, the chief foods eaten by the trout examined were water fleas and midge larvae and pupae. Phantom midge larvae, terrestrial insects and parts of aquatic plants occurred in lesser abundance.

ESTIMATED ANNUAL PRODUCTION OF TROUT

As noted above, the total standing crop of available bottom foods was shown to be 6,860 pounds. In addition, plankton and drift foods will also furnish a considerable amount of food but it is not possible to arrive at a definite weight of food supplied by these two sources. Further, since considerable replacement or "turn-over" of bottom foods takes place annually, we are justified, I believe, in taking two times 6,860 pounds or 13,720 pounds as the total estimated weight of all foods available to trout in Lake Arrowhead annually. It should be made clear that such fishcultural facts relating to the total weight of plankton and drift foods or rates of replacement of all foods and their actual availability to trout as compared to their "potential" availability, have not been worked out on a scientific basis as yet and the facts will carry us only part of the distance in developing really scientific stocking policies today. Accumulated fishcultural experience and detailed studies of the type made here offer a far firmer starting basis, however, than the guesses of individuals unacquainted with the biological problems involved.

To continue, if an estimated total of 13,720 pounds of food is available to trout annually in Lake Arrowhead and if it requires approximately eight pounds of natural food to produce one pound of trout, then an estimated total of 1,715 pounds of trout should be produced annually. If the trout run about the same average weight and length as those taken in the gill net catches (approximately half a pound apiece or eight to ten inches in length), they will run from two to three to the pound. Using the figure of 2.5 fish to the pound, this would give an annual production of approximately 4,300 trout or 5.7 fish per acre. Since the catfish, sunfish and goldfish present will consume a portion of the food, these figures would have to be reduced somewhat. It is the writer's opinion after figuring production from all aspects, that the lake should produce between 3,000 and 5,000 trout annually as a rough estimate of the lower and upper limits.

STOCKING POLICY

Submitted below in Table 9, are two alternate stocking policies for Lake Arrowhead. The numbers and sizes recommended in each are based upon the estimated "biological capacity" of the lake from studies made of the food supply given above.

If only small fish around one inch in length are to be available for planting purposes, 300,000 (policy 1) of this size planted annually should give a return of from 3,000 to 6,000 fish annually to fishermen. It seems evident from examination of the egg "take" records of previous years at Arrowhead that ample eggs could be secured to eye, to hatch and to plant this number of fish annually, provided, of course, that the adult breeding population is not removed by over-fishing. Planting of small fish would be the cheapest method, but probably also, the least satisfactory for reasons noted below. Trout planted when an inch in length would be taken by anglers in their second summer, but by far the greatest number would be taken in their third summer, and the survivors in their fourth and later years.

TABLE 9

Two Stocking Policies Recommended for Lake Arrowhead

Policy no.	Species	Size in inches	No. per acre*	Total	Frequency	Expected mortality, percentage
1	Rainbow -----	1	400	300,000	annually	98-99
2	Rainbow -----	3-4	26.6-40	20,000-30,000	annually	40-60

* Based on surface area of 750 acres when the elevation of the lake is 5,102 feet.

Policy 2, which recommends from 20,000 to 30,000 rainbow trout from three to four inches in length, would give more immediate and better results though the cost of raising same would be considerably higher than for the smaller fish. These fish, if reared in Lake Arrowhead Hatchery from eggs taken in the lake, would have to be held and fed in the rearing ponds until September or October when they should average between three and four inches in length. It would be best to plant them with the advent of low water temperatures in the fall, as the cost of labor and food would overbalance the very poor growth obtainable over the winter months. In addition, by planting them after the fishing season had closed, greater protection would be afforded and many would have achieved good pan size by the opening of the fishing season the following spring.

In intensively fished waters such as Lake Arrowhead, far better results will be had by planting large fish. This has been proved time and again by past fishcultural experience.

The carrying capacity of a body of water is far greater than its biological capacity. For instance, it would be possible to plant say 25,000 large fish over six inches long annually in the lake and food capacity might be sufficient to maintain or "to carry" them but it would be insufficient to permit proper growth. Further, trout of this size are usually planted with the expectation that over 95 per cent of them will be removed in the same fishing season in which they are planted. This system could be followed in Arrowhead if the funds to rear or to buy trout over six inches long were available, but it seems to the writer that utilization of the normal productivity of the lake by means of carefully balanced management and stocking procedures would give more satisfactory results in the long run. The lake will never, biologically, be able to produce all the pounds of fish that the hundreds of anglers who fish it would like to catch. The two alternatives are to plant large numbers of fish six inches or larger in size

regardless of the available food supply, or to plant smaller numbers consistent with the biological capacity of the lake and then restrict the "take" in proper relation to the supply.

While the writer recommends stocking policy 2 (table 9), the numbers suggested may be somewhat high in relation to actual food conditions. However, it is anticipated that if three- to four-inch fish are planted in the fall, by the following summer many will be of catchable size and will be removed at this time, which in turn reduces the demand for food by the total remaining population. Further, to plant three- to four-inch fish is to produce a considerable "poundage" of the fish on artificial food in the rearing operations, the fish are protected over the period of greatest mortality when young, and the drain on the food supply is limited to the amounts necessary to grow them to say six inches or a catchable size when many will promptly be caught by anglers. In other words, using policy 2 is "stepping up" potential production by the lake without menacing the amount of food available to permit good growth of the survivors of each fishing season to sexual maturity.

A real danger exists in over-stocking in relation to the food supply. If this is done, big headed fish of poor condition will result, and in a case of this kind it is far better to plant too few rather than too many. It is believed that neither of the policies submitted is out of line with the basic food conditons in the lake.

The policies submitted are in no sense final. They should be carefully balanced against actual catch records annually and modified as appears necessary. Further, in case new food organisms and plants are introduced and become established to improve the food supply, it may be possible to greatly increase the numbers planted and consequently fish production of the lake. The number of trout trapped annually for egg collections and their size, growth and condition will give further evidence of necessary modifications both as to planning and restrictive measures.

CATCH RECORDS

It is suggested that a record be obtained of all fish caught by fishermen on the lake. From a record of this kind the catch per unit of effort could be determined as well as a fair estimate of the total annual catch. This would give direct means of measuring the trend of fishing from year to year following upon any stocking policy or management plan put into effect. Report blanks for recording catches made by anglers could be printed and supplied in book or pad form. Two types of blanks would be desirable; one for recording reports of boat fishermen and one for anglers who fish from the shore.

Since voluntary returns obtained from anglers have been proved quite incomplete and inaccurate as shown by past catch record work, special persons such as wardens, hatcherymen, boatmen or others would have to be assigned to take down the records by contacting anglers. It is most difficult to get anglers to record their catches. They are usually in too much of a hurry or they find it too much trouble to study the blanks provided to learn how to fill them out properly, and it appears now that if adequate voluntary catch records are to be obtained they must be taken under the very close supervision of trained workers or by other special means.

One most important aspect is that the record be filled out immediately upon conclusion of any given fishing period for any one day before remembrance of catch and hours fished had faded. To determine catch per unit of effort, it is highly important that the *hours fished* be recorded. Blanks should be filled out for all fishermen regardless of *whether or not* fish are actually caught.

If the above suggestion for obtaining catch records on Lake Arrowhead is placed in operation, the facts determined should form a sound basis upon which to erect future management and stocking policies. Such records would also assist in the development of better methods of management with regard to similar bodies of water.

GENERAL RECOMMENDATIONS

A. As to Protective Measures

1. Open fishing season of four months, from June 1st to September 30th, or possibly May 15th to September 15th.
2. Daily bag limit of ten trout or five pounds and one trout.
3. Daily bag limits of twelve catfish and twenty sunfish.
4. Minimum size limit of six inches on trout; no size limit on catfish or sunfish.
5. Rigid protection of large trout from poachers when on their spawning migrations into the small tributary streams in the spring.

An open season of six months and a bag limit of twenty-five trout regardless of size as now in effect, are entirely out of proportion to the supply of available fish in a lake as accessible and as intensively fished as Lake Arrowhead. A size limit prevents wholesale slaughter of immature trout and makes for greater poundage rather than numbers in the catches. If no size limit is put into effect in the lake, then stocking policy No. 1 (table 9) is recommended because the larger fish suggested under policy No. 2 should be given a chance to reach good pan size before they are caught.

A reduction of bag limit lowers the limit catches of expert fishermen and gives greater spread of the fish supply among a greater number of anglers.

B. As to Hatchery and Planting Operations

1. Take surface water supply from lake for hatchery and rearing ponds and use by mixing with present supply from the 80-foot level.
2. Redesign and rebuild present hatchery ponds into raceways for more efficient operation.
3. Take eggs by trapping spawners annually.
4. Plant only rainbow trout.
5. Secure catch records annually.
6. Plant all trout in dense weed bed areas in shallow bays and along shores where good protection will be had. Distribute only a few at any one place; distribute as widely as possible.

The present trough capacity of the hatchery is adequate to hatch all eggs needed for stocking Lake Arrowhead. The present pond

system at the hatchery could be improved for more efficient operation. Shallow concrete raceways, 20 feet long by 3 or 4 feet wide, with concrete bottoms having adjustable depths from 6 to 18 inches, would be more efficient both from feeding and disease control standpoints.

Water supplied from the surface of the lake will permit mixing the present cold water taken from the 80-foot level with warmer surface water to obtain any temperature between the minimum and maximum of either source of supply and will give far better growing temperatures, at least in the warmer months, for hatchery and rearing pond operations. Unless better growing temperatures than from 42° F. to 46° F. are obtained, operation of the hatchery is not recommended.

The ultimate degree of success attained in egg collecting, hatching and rearing operations will depend entirely upon the training and ability of the man in charge of the work. Accurate cost records of all operations should be kept. Mortality records, food fed, water temperatures, growth rates and similar data will give an index of the costs involved that can be used as a check on the results obtained. Modern trout diets should be used as well as modern methods of disease control.

C. As to Improvement of the Natural Food Supply in Lake Arrowhead

1. The introduction of two kinds of snails, *Lymnaea* and *Physa,* both of which normally occur in similar lakes.
2. Introduce the small scud, *Hyalella azteca,* and the large scud, *Gammarus limnaeus.*
3. Introduction of the aquatic plant, *Elodea.*

The introduction of the above organisms, if successful, would do much to improve the food supply of Lake Arrowhead. Conditions seem best suited to the snails and the small scud (*Hyalella*), though an attempt should be made with the large scud (*Gammarus*) as well. It is impossible to predict success or failure from such attempts in the present state of our knowledge. All the above forms can be found growing naturally in lakes or streams of the middle Sierras.

One point that should be mentioned in connection with natural food supply is the danger to same of oil pollution from motor boats operated on the lake. Oil on water is very harmful to aquatic insects, often preventing their normal emergence from the water and later reproduction. There is a very real danger in this respect at Lake Arrowhead due to large numbers of boats concentrated in a comparatively small area. No evidence of oil pollution was seen at the time the survey work reported on here was conducted.

In conclusion, if Lake Arrowhead is to be brought to its maximum productivity, carefully planned stocking and management policies must be placed in effect. If these are modified from year to year in light of additional facts, produced both by catch records showing the annual range and size of the fish crops, and by later biological re-surveys to determine changes in the food supply, fishing in the lake should be steadily improved from season to season.

A METAL PLANKTON NET [1]

By Donald H. Fry, Jr.
California State Fisheries Laboratory
Division of Fish and Game

The California sardine and the Pacific mackerel both spawn in the open ocean. The eggs float freely in the water and hatch in less than a week (the exact time depends on temperature and may be as short as two days). The California Division of Fish and Game is engaged in mapping the areas in which the spawning is done, and in noting changes from year to year. This work is done by towing cone-shaped nets behind the research boat. If no eggs are taken we know that there has been no spawning of any importance in that spot during the previous week, conversely if we do find eggs we know that there has been some spawning. As a general rule there is no need to take ocean currents into account in studying eggs which hatch as quickly as do those of the sardine and mackerel.

Part of the egg collecting work is done with a special metal net, designed at the California State Fisheries Laboratory. There would have been no need for this piece of equipment if sardine and mackerel eggs were always uniformly distributed throughout large areas of water. It was the discovery that their distribution is often very patchy that led to the building of a metal net which could be towed continually at the ten-knot cruising speed of our research boat. With this device we are able to pass through waters where we do not expect to find anything and be absolutely sure that we have not missed any patches of eggs. To do this with the usual type of silk net would require a haul every 10 or 15 miles and a loss of 15 or 20 minutes for each haul, i.e., a loss of four to eight hours per day.

Though not intended for fish larvae, this net takes a surprising number of them in spite of its small opening. Apparently its high speed simply does not give the larvae time to get out of the way.

When towed at 10 knots, the metal net is never more than a few feet under the surface. This makes it useless for even roughly estimating the quantities of eggs in a given area, and for some species of fish would make it entirely useless. Fortunately for us, sardine and mackerel eggs float in the upper layers of water, so we can always be sure of picking up some if they are present in large enough numbers to be worth considering. Fish eggs are often very much more abundant at one depth than at another, hence to arrive at any sort of an estimate of the numbers in an area, it is necessary to sink a tow net below the deepest depth at which the eggs are found and drag it to the surface either vertically, diagonally, or in a series of horizontal drags at different depths. About 150 feet appears to be deep enough when collecting sardine or mackerel eggs.

[1] Submitted for publication, August, 1937.

The metal net is constructed of stainless steel throughout. It is five feet long and has a four-inch opening (Fig. 89). Back of the opening there is a collar which widens to 10 inches, and then comes a cone of screen, 40 meshes to the inch. This screen is guarded by a frame of stainless steel. The small opening and large area of screen combine to give plenty of filtering surface and so reduce back pressure inside the net. The large screen area also takes much longer to clog than would a smaller screen with the same sized opening. At the lower end is a cup which screws in place. A small screen-covered opening in the side of this container lets some water flow through and makes sure that everything that gets into the net washes well down into the cup.

The net is towed on the end of a $\frac{3}{8}$-inch steel cable; not because anything that strong is needed but because the weight of the cable helps sink it under water. Two hundred and fifty to 300 feet of cable will sink the net far enough so that it will not break the surface. When given less than 200 feet of cable, it will pop through a wave every now and then, and when really close to the boat it skitters and bounces along the surface.

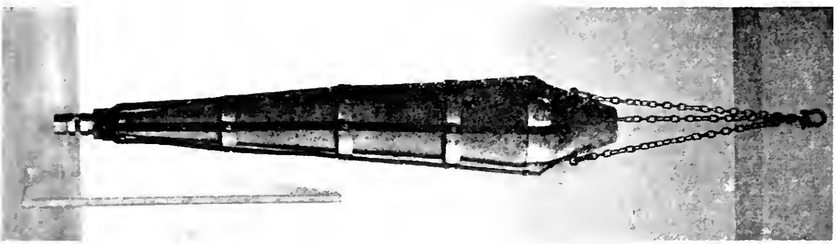

FIG. 89. The high speed metal plankton net developed by the author. The measuring stick is one meter ($39\frac{3}{8}$ inches) long.

Material caught in the metal net is shaken up pretty badly. All the fish larvae and a majority of the small crustaceans are killed, but fish eggs are usually still living and uninjured.

The net is usually hauled in every two, three or four hours. The time depends on the rapidity with which water conditions are changing. Once one of our research men, while holding onto the widely cavorting boat with both hands, shouted, "As far as I am concerned that net can stay out till it calms down a little. I don't want to get washed overboard." That haul lasted eight hours.

When the net is brought aboard it is reeled in rapidly until within a few feet of the boat, then the winch is stopped and started again as slowly as it will go. This precaution is necessary to keep the net from jumping out of the water and slamming into the rail. When it is pulled in slowly a man can catch it and fend it off until it has been reeled right up to the block (this block is hung over the stern and about ten feet above deck level). Then the cup is unscrewed and emptied. If the screen is clogged, the meshes are blown clear with a strong stream of salt water. Then the cup is replaced, the entire rig is dropped overboard, and the cable payed out under slight tension.

OCCURRENCE OF MACKEREL-SCAD IN SOUTHERN CALIFORNIA[1]

By RICHARD S. CROKER
California State Fisheries Laboratory
Division of Fish and Game

The first mackerel-scad, *Decapterus sanctae helenae* (Cuvier and Valenciennes), to be recorded for California was taken at Catalina Island on June 25, 1937. It was caught on hook and line, with an anchovy for bait, aboard the pleasure fishing boat *Sunshine II*. J. Charles Davis, 2d, very kindly turned the specimen over to the California Division of Fish and Game. This fish is a member of the family Carangidae and is quite similar in appearance to the common California horse mackerel, *Trachurus symmetricus*. It is likely that other individuals have been taken in California waters, but because of their similarity to the horse mackerel have been confused with it and not reported.

The specimen was 21 inches (53 centimeters) in total length, far larger than most fish of the same and related species recorded from other parts of the world. It was brilliant in color, being bluish-green on the back with a wide orange-red stripe along the lateral line. There was a black spot at the posterior edge of the opercle.

Until we have more specimens at hand this fish can only be tentatively designated as *Decapterus sanctae helenae*. The differences between the generally recognized species of *Decapterus* are at the best slight, and being based on small numbers of usually immature specimens are far from conclusive. The present fish is presumably a mature individual, hence some of the characters given for various species of *Decapterus*, based on immature specimens and which change with age (teeth, length of pectoral fin, body shape, etc.) do not fit. However, it could be assigned to any of several of the species recognized by Norman (1935). Similarly, it could be identified as several of the species recognized by Nichols (1936), who does not agree in all details with Norman's analysis of the genus. According to Walford (1937) it would most likely be *D. sanctae helenae*. The accompanying chart lists the characters of those species most easily confused.

An enumeration of the diagnostic characters of our specimen is as follows: vomerine teeth present but minute, in a T-shaped patch; palatine teeth absent; minute teeth on tongue; gill rakers on lower part of anterior arch 38; length of pectoral 1.34 in head; scales in lateral line 90 plus about 28 more or less well-developed scutes at posterior end (it is difficult to determine at which point the normal scales end and the scutes begin; also the number varies as there are 27 on one side and 29 on the other); the first scutes begin below posterior portion of second dorsal fin; second dorsal with 33 rays; anal with 28 rays.

[1] Submitted for publication, August, 1937.

The genus *Decapterus* is cosmopolitan in warm seas, and it is within reason to suspect that geographical races of one or two root species have developed. It seems likely that the various forms found in the Atlantic Ocean, Indian Ocean, western Pacific and eastern Pacific are all races of the one species originally named *Caranx sanctae helenae* by Cuvier and Valenciennes in 1833.

Diagnostic Characters of Certain Species of Decapterus*

	Catalina Island specimen	*D. sanctae helenae*	*D. hypodus*	*D. lajang*	*D. pinnulatus*	*D. macrosoma*	*D. muroadsi*
Total scales in lateral line	119 or 120	122 to 130	105 to 115	125 to 127	120 to 125	115 to 123	106 to 108
Scutes only	27 to 29	22 to 25	30 to 33	27 to 28	20 to 25	28 to 30	26 to 28
Pectoral fin in head	1.34	1.2 to 1.6	1.5	1.2 to 1.4	1.6 to 1.67	1.5	----------
Gill rakers, lower part of anterior arch	38	32 to 41	32	30	37	33 to 35	----------
Rays in second dorsal fin	33	30 to 35	32 or 33	34 or 35	32 or 33	34 or 35	33
Rays in anal fin	28	26 to 30	25 to 27	28 to 31	28 or 29	28 to 30	28
Palatine teeth	Absent	Absent	Present, feeble	Present	Usually absent	Absent	----------
Vomerine teeth	Present	Sometimes absent	Present	Present	Apparently none	Present	----------
Teeth on tongue	Present	Sometimes present	Present	Present	Present	Present	----------
Habitat as given	California	Atlantic	Pacific coast of Mexico	East Africa to Japan	Polynesia	East Africa to Japan	Japan

* Characters as given by Norman (1935), except that those for *D. muroadsi* are from Nichols (1936).

A second specimen, undoubtedly the same species although it was only superficially examined, was seen by the writer at San Diego on August 16, 1937. It had been taken that day on hook and line at Los Coronados Islands, Lower California, aboard the pleasure fishing boat *Sportfisher II*. It was almost identical in size with the first specimen.

The San Diego pleasure party boats fishing at Los Coronados Islands during the summer of 1937 have frequently reported horse mackerel when making out their daily catch records. It seems probable that many of these were in reality mackerel-scads. Although the common horse mackerel averages one to two pounds in weight, these reports have indicated an average size of two to four pounds. Furthermore the ordinary horse mackerel does not frequently bite on the live bait customarily used on the San Diego fishing boats.

The definite record of the capture of these two fish is interesting in that it helps to run down the persistent rumor of large "horse mackerel" in Lower California waters. For about a year we have been hearing of large schools of fish that looked like horse mackerel. Tuna fishermen have reported catching quantities of them near Cerros Island, San Benito Islands and Turtle Bay. They said the fish were much larger than the common horse mackerel, running around three to four pounds. Unlike the horse mackerel, they would come up to the surface and take the feather lures used for tuna, even when tuna were schooled and biting. Other fishermen have reported seeing and catching numbers of fish similar to horse mackerel in the southern part of Sebastian Viscaino Bay, Lower California. They were schooled with Pacific mackerel. These fish, which are sometimes present by the thousands, are said to average about three pounds in weight. Their coloration,

light blue on the back with a faint yellowish stripe, has caused the fishermen to distinguish them from the ordinary horse mackerel.

It is my belief that these various reports can all be considered as referring to *Decapterus sanctae helenae.* This would indicate a large population of this little known fish along the Lower California coast, and extending into southern California. It is hoped that additional specimens can be obtained which may serve to throw further light on this complex genus.

REFERENCES

NICHOLS, J. T.
1936. On *Decapterus scombrinus* (Valenciennes). American Mus. Novitates, no. 835, 6 pp.

NORMAN, J. R.
1935. The carangid fishes of the genus *Decapterus* Bleeker. Ann. Mag. Nat. Hist., 10 ser., vol. 16, no. 92, pp. 252-264, 4 figs.

WALFORD, LIONEL A.
1937. Marine game fishes of the Pacific coast from Alaska to the equator. Berkeley, Univ. Calif. Press, p. 82.

EDITORIALS and NOTES

VOLUME 23 OCTOBER, 1937 Number 4

DUCKS UNLIMITED

The decline in the numbers of wild ducks and geese in North America has reached alarming proportions. Several factors contribute to the decline, and many remedies have been proposed. There is no doubt, however, that the basic cause of this depletion is the destruction of breeding grounds, both by drought and by the encroachment of agriculture. It is essential that wildfowl breeding grounds be restored. The U. S. Biological Survey and several state conservation agencies have made a good start by flooding considerable areas in the United States and restoring them as breeding grounds (*California Fish and Game*, vol. 23, no. 1, pp. 59-66). However, most of the ducks are produced on Canadian breeding grounds, which are in poor condition due to several years of drought, and some of which have been ruined by conversion to wheat fields. It would not be fair to ask Canadian authorities to spend money raising ducks for American hunters to kill, as it is a fact that most of the shooting is done in the United States. Hence, prominent sportsmen and conservationists in both countries have banded together, forming an organization that will go a long way toward restoring the "good old days" so dear to the memory of the wildfowler. This organization is supported, as one editor said, "by those who like to shoot ducks, by those who like to eat the ducks their friends shoot and by those who like the sight of all wildlife in its natural state."

It is believed that the readers of *California Fish and Game* would be interested in hearing of this international movement to restore the duck population of North America. In a previous issue (vol. 23, no. 1, pp. 31-35), John C. Huntington, vice president, More Game Birds in America, a Foundation, described existing conditions and outlined the fact finding work of his organization. In response to our queries regarding recent progress and aims, John B. Coleman, State Chairman of Ducks Unlimited has written us under date of August 26, 1937, as follows:

"In answer to your request for further information regarding the project 'Ducks Unlimited,' I will give you my idea as to what it stands for and means:

"Ducks Unlimited was financed by More Game Birds in America, a Foundation, which furnished the funds to organize all the States in the Union, appointed chairmen through the different States and allocated a quota to each State based on the number of hunters and amounts invested in duck grounds. The different States are now at work on their quotas which, in the aggregate, will total $600,000 per year for the period of five years, or a total of $3,000,000 in subscriptions.

"Ducks Unlimited presents a practical plan to perpetuate and steadily improve the duck situation in the United States by the production of millions of more wild ducks annually, through the restoration and business-like management of the Canadian duck breeding grounds. The possibilities of increasing the duck situation are unlimited and without any doubt the work of the organization, when fully on its way, should show an increase of millions of ducks annually. It surely presents an opportunity for the sportsmen of this country to end the 'Duck Depression' and the cost will be insignificant when compared with the results.

"The starting point in this work will be the restoration and rehabilitation of those large areas in the Canadian Provinces of Alberta, Saskatchewan and Manitoba, where it is estimated about seventy-five to eighty per cent of our duck population is annually produced. Ducks Unlimited proposes to spend $600,000 annually in the Canadian area for a period of five years in acquiring lands, land development, management of lands, supervision and improvements, fact-finding, etc. Canada already is doing her share and is willing to do more by setting aside hundreds of thousands of acres. They have organized and incorporated Ducks Unlimited (Canada) and appointed four directors who will serve in conjunction with a like number from the United States. These public-spirited sportsmen will serve without remuneration and have complete charge of the program.

"The necessary work will involve—

1. Preservation of existing breeding grounds in the zone above mentioned and competent supervision of such areas to assure their continued productivity.
2. Restoration of former exceedingly productive breeding grounds by reconditioning those which still exist but whose usefulness has been impaired; and managing such areas so as to assure maximum duck crops.
3. Controlling predators, preventing disease and impounding water, all of which will materially increase the duck crop.
4. Setting aside the most productive duck breeding areas as permanent sanctuaries by the Canadian Government.

"Every dollar contributed to Ducks Unlimited will be spent to promote more ducks in Canada where duck restoration dollars will produce the best results.

"The major items for the five year program are as follows:

Land acquisition	$700,000
Land development	1,350,000
Management of lands	350,000
Miscellaneous activities in the southern zone	80,000
Supervision and improvements on public lands	220,000
Fact-finding	60,000
Overhead	210,000
Total	$2,970,000

"In order to carry out this extensive program efficiently, to avoid costly errors and to obtain the best possible returns in the shape of

more ducks for each dollar expended, a sound, well-managed business organization is necessary. Such an organization is Ducks Unlimited (Canada), a nonprofit corporation, incorporated under the laws of the Dominion of Canada, which will be assisted in every way by Ducks Unlimited (United States).

"Subscribers to Ducks Unlimited are thereby assured of careful and efficient expenditure of the funds they contributed.

"It is the opinion of the New York office that work will be started in Canada after the first thaw in the spring of 1938.

"In all my forty years' experience hunting in California, I have never had a proposition submitted to me so appealing and worthy of the support of every sportsman in the country."

OCEAN SUNFISH IN SAN PABLO BAY

The ocean sunfish, *Mola mola*, belonging to the head-fish family Molidae, looks as if it might be only the head of a large fish and that someone had forgotten to attach a body and regulation tail. This odd looking animal has a caudal fin but it is little more than a ragged fringe along the posterior side of the body. Supposedly the circular shape of the body and its flattened or compressed appearance suggested a mill-wheel to Linnaeus for he named it "mill-wheel" (mola).[1] The weird appearance of this fairly common fish has been useful to imaginative newspaper reporters and about every two years the papers carry a picture of the sunfish with a story of a creature unknown to everyone along the waterfront.

This fish is often caught in the nets of sardine fishermen operating off San Francisco, Monterey, San Pedro and San Diego. It seems to be especially abundant in Monterey Bay where it is seen turned on its side idling at the surface as though sunning itself. Usually the fish is only 2 or 3 feet long, but one landed at Redondo Beach in southern California was 8 feet 2 inches long and weighed 1,200 pounds. One, only slightly smaller than this, was caught at San Diego three years ago, and large specimens are sometimes seen at Monterey.

Occasionally there are reports of this fish having been seen in San Francisco Bay. There is a definite record of a 7½-pound sunfish caught August 9, 1937, on hook and line at the Mare Island Lighthouse at the lower end of Carquinez Strait. A few days before this, a sunfish is said to have been gaffed in Mare Island Strait, so it is evident that ocean sunfish do occasionally invade upper San Pablo Bay as far as Carquinez Strait.

This fish is supposed to be a plankton feeder, eating only minute organisms from the water, but the 7½-pound fish mentioned above was taken on a hook baited with a piece of sardine. Another *Mola* was reported as being taken on hook and line during the summer of 1937. It was caught off San Pedro on a hook baited with a live anchovy. These occurrences are not unprecedented, however, for there are other instances of plankton feeders that vary the monotony by taking baited hooks occasionally.—*W. L. Scofield, California State Fisheries Laboratory, August, 1937.*

[1] See the photograph of the sunfish in "Calif. Fish and Game," vol. 22, no. 1, p. 49, 1936.

RECORD MACKEREL TAKEN AT MONTERY

The largest Pacific mackerel, *Pneumatophorus diego*, on record was landed at Monterey, California, on August 11, 1937. The fish measured 24½ inches in total length and weighed exactly six pounds. Its greatest depth, from back to belly, was five inches.

Manuel Balesteri and his crew caught this huge mackerel in a lampara net haul, along with 1,000 pounds of ordinary mackerel, about one mile east of the Pt. Pinos Lighthouse, near Pacific Grove.

The largest mackerel taken along the Pacific Coast seldom are more than 20 inches long or over three pounds in weight. The previous definite size record was of an individual taken at San Pedro that was 22¼ inches in length and 3½ pounds in weight.—*J. B. Phillips, California State Fisheries Laboratory, August 16, 1937.*

FUR-BEARING MAMMALS OF CALIFORNIA

One of the greatest pleasures an editor can have is to review a book of the caliber of the one under discussion. *Fur-bearing mammals of California, their natural history, systematic status, and relations to man,* by Joseph Grinnell, Joseph S. Dixon and Jean M. Linsdale[1] is a fine example of what a book on natural history should be but not always is. Its treatment of the field it sets out to cover is complete from every standpoint. Its style is such that the beginning student can understand it, and reading it be inspired to go forth and learn more about fur-bearers in the wild. Yet its pages of factual information contain many details that no one wildlife investigator could ever hope to run across in the field. The typography, reproduction of illustrations and general makeup are in the usual manner of the University of California Press—that is to say, splendid.

Many years ago the authors laid plans for the publication of a treatise on the fur-bearers of California. Rather than rush to press with a sketchy account they took their time and evolved the book which will stand as a model in its field. In general the material presented was derived from four sources. First of all were the field and laboratory observations of the authors. Supplementing these were the notes of their students. The published observations of other scientists and historians furnished considerable information. Perhaps the most interesting parts are those based on the observations of outdoor men who were contacted personally or by letter. The outside sources of material included trappers, hunters, stockmen, "old settlers," Division of Fish and Game employees, U. S. Forest Service and National Park officers, and nature lovers in general. All outside material, as well as the authors' own, was carefully checked. Division of Fish and Game records of trappers' catches were used.

The field covered by the term "fur-bearing mammal" is explained by the authors as follows: "The restricting definition for 'fur-bearing mammal' is that a given kind, in order to warrant inclusion in our treatise, must have had positive commercial value as a producer of 'furs.' Out of about 60 'groups' of free-living mammals in California,

[1] Contribution from the Museum of Vertebrate Zoology, University of California. University of California Press, Berkeley, 1937.

25 meet this definition and are therefore given more or less extended attention. It is true that certain other groups, such as moles, gray squirrels, and jack rabbits, have occasionally been levied upon and their pelts marketed; but this has happened so rarely, or in such meager measure, that we have not felt justified in including them among the fur producers worth serious consideration."

The animals discussed are: opossum, bears, coons, ring-tailed cats, martens, fisher, weasels, mink, wolverine, otters, skunks, badgers, foxes, coyotes, wolf, mountain lion, wildcats, fur seals, beavers and muskrats. Under each species are the pertinent details in fine type, followed by a discussion in large type of the natural history, abundance and importance of the animal.

Preceding the accounts of the individual species are several chapters of great interest dealing with the history of fur trapping in California, present day fur trapping, effects of fur mammals upon the activities of man, effects of the activities of man upon fur mammals, population trends of fur-bearers, and fur farming.

Throughout, the authors impress us with the need for conservation of our fur-bearers. Although they admit that certain species are detrimental (to a greater or less extent) to livestock, poultry, crops or game, they stress the point that on the whole the fur-bearing group is of great positive economic value. For example, many fur-bearers prey upon destructive rodents, insects and other "vermin," thus saving the farmer untold thousands of dollars. Furthermore, the monetary value of the California fur crop is considerable (estimated at $220.000 in 1924), and this harvest can be maintained at a high level as long as over-trapping does not occur. Some of the species are usful as game, some as food, and all are valuable in that they bring pleasure to nature lovers who are fortunate enough to see them in their natural haunts.

The two volumes of *Fur-bearing mammals of California* contain 777 pages, 13 colored plates and 345 figures. The colored paintings of animals were made by Major Allan Brooks, and are up to his usual high standard. The figures consist of line drawings to illustrate structural details, and photographs and wash drawings of the animals, their homes and their habitat. A bibliography and an index complete the book.—*Richard S. Croker, Editor, California Fish and Game.*

REPORTS

DEPARTMENT OF NATURAL RESOURCES, DIVISION OF FISH AND GAME, STATEMENT OF REVENUE

For the Period July 1, 1936, to June 30, 1937, of the Eighty-eighth Fiscal Year

	Detail	Total
Revenue for the Fish and Game Preservation Fund, Current Year		
License sales:		
Angling licenses, 1936	$441,686 50	
Angling licenses, 1937	147,116 95	
Commercial hunting club licenses, 1936-1937	750 00	
Commercial hunting club operators' licenses, 1936-1937	145 00	
Deer tags, 1936	126,852 00	
Deer tags, 1937	2 00	
Fish breeders' licenses, 1936	30 00	
Fish breeders' licenses, 1937	340 00	
Fish importers' licenses, 1936	5 00	
Fish importers' licenses, 1937	80 00	
Fish packers and wholesale shellfish dealers licenses, 1936-1937	1,130 00	
Fishing party vessel permit, 1937	231 00	
Fishing party vessel permit, 1936	59 00	
Game breeders' licenses, 1936	120 00	
Game breeders, 1937	1,075 00	
Hunting licenses, 1934-1935	661 16	
Hunting licenses, 1935-1936	19,851 00	
Hunting licenses, 1936-1937	414,225 50	
Hunting licenses, 1937-1938	60 00	
Kelp licenses, 1936	10 00	
Kelp licenses, 1937	20 00	
Market fishermen's licenses, 1936-1937	41,760 00	
Market fishermen's licenses, 1937-1938	32,690 00	
Trapping licenses, 1936-1937	2,093 00	
Total licenses sales		$1,230,993 11
Other income:		
Court fines	$63,094 02	
Fish packers tax	317,052 19	
Fish tag sales	2,727 54	
Game tag sales	211 17	
Importers' contributions	230 00	
Interest on bank balances	6,086 10	
Kelp tax	174 80	
Lease of kelp beds	1,592 80	
Miscellaneous sales	5,651 24	
Publication sales	249 43	
Salmon tax—Chap. 1015-35	22,893 18	
Total other income		$419,962 47
Prior year revenue 87th fiscal year—		
Publication sales	$45 74	
		$45 74
Total revenue for the Fish and Game Preservation Fund		$1,651,001 32
Revenue for the General Fund		
Unclaimed checks and deposits		2 25
Grand total, all funds		$1,651,003 57

STATEMENT OF EXPENDITURES

For the Period July 1, 1936, to June 30, 1937, of the Eighty-eighth Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
OPERATING EXPENDITURES, EIGHTY-EIGHTH FISCAL YEAR					
Administration:					
Executive	$5,000 00				$5,000 00
General office	5,670 00	$1,701 34	$1,487 68	$250 31	9,109 33
Printing, general		4,148 39			4,148 39
Printing Fish and Game Magazine		1,623 86			1,623 86
Automobiles		364 27	218 77		583 04
Traveling			2,294 56		2,294 56
Postage			4,105 38		4,105 38
Telephone and telegraph			4,175 44		4,175 44
Freight, cartage and express			848 71		848 71
Rent			11,017 61		11,017 61
Accident and death claims			3,734 55		3,734 55
Departmental administration, pro rata	12,233 95		266 05		12,500 00
Librarian	1,650 00	188 23	72 63	140 02	2,050 88
Legal			4,770 83		4,770 83
Premiums on bonds			35 00		35 00
Publicity			1,238 22		1,238 22
Pro rata General Fund expense, Chap. 923-33			6,496 93		6,496 93
Sales tax on sales			—7 78		—7 78
Temporary help	394 19				394 19
Total Administration	$24,948 14	$8,026 09	$40,754 58	$390 33	$74,119 14
Patrol and Law Enforcement:					
Chief and assistants	$14,653 06				$14,653 06
General office	4,852 51	$263 78	$49 22	$68 17	5,233 68
Automobiles		35,539 27	15,114 81	26,138 20	76,792 28
Traveling			50,603 89		50,603 89
Postage			793 17		793 17
Telephone and telegraph			2,498 33		2,498 33
Freight, cartage and express			2 73		2 73
Rent			876 48		876 48
Heat, light, water and power			8 72		8 72
Captains and wardens	205,685 86	645 37	1,092 37	115 41	207,539 01
Launches	9,986 44	11,801 14	7,305 93	23,510 43	52,603 94
Premiums on bonds			63 48		63 48
Temporary help	1,642 29				1,642 29
Assistant fish and game wardens, seasonal	22,814 03				22,814 03
Total Patrol and Law Enforcement	$259,634 19	$48,249 56	$78,409 13	$49,832 21	$436,125 09
Commercial Fisheries:					
Chief and assistant	$10,440 00				$10,440 00
General office	8,419 11	$46 24	$25 34	$278 83	8,769 52
Automobiles		680 17	332 46	623 15	1,635 78
Travel			7,343 61		7,343 61
Telephone and telegraph			829 90		829 90
Freight, cartage and express			223 92		223 92
Rent			151 51		151 51
Heat, light, water and power			623 19		623 19
Research, oyster	2,280 00	66 59			2,346 59
Laboratory	30,062 42	2,361 55	1,712 52	2,375 69	36,512 18
Fish tags		327 33			327 33
Cooperative Research		30 38	16,000 00		16,030 38
Statistics		1,353 29	2,110 39	255 21	3,718 89
Temporary help	897 09				897 09
Terminal Island grounds	1,050 00	26 23	9 43	7 67	1,093 33
Fish cannery auditing			2,665 00		2,665 00
Total Commercial Fisheries	$53,148 62	$4,891 78	$32,027 27	$3,540 55	$93,608 22
Fish Conservation:					
Chief and assistant	$6,865 81	$4 53			$6,870 34
General office	4,838 12	12 26	$13 15	$22 19	4,885 72
Automobiles		10,793 10	4,397 27	5,896 31	21,086 68
Travel			10,062 47		10,062 47
Postage			184 34		184 34
Telephone and telegraph			1,192 66		1,192 66
Freight, cartage and express			573 90		573 90
Rent			1,875 49		1,875 49
Heat, light, water and power			2,338 32		2,338 32
Research (oyster)		105 51	309 17	82 03	496 71
Fish planting		605 69	1,754 77	583 50	2,943 96
Hatcheries	109,402 08	59,258 10	943 50	1,079 29	170,682 97
Fish cars	1,800 00	1 44	962 64		2,764 08
Blue printing			6 85		6 85

STATEMENT OF EXPENDITURES—Continued

For the Period July 1, 1936, to June 30, 1937, of the Eighty-eighth Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Fish Conservation—Continued					
Cooperative research	$2,263 23	$191 13	$180 14	$21 33	$2,655 83
Statistical	1,598 71	77	1,122 99		2,722 47
Temporary help	1,093 69				1,093 69
Special field	13,880 00	88 67	10 71	11 49	13,990 87
Fish rescue	1,920 00	41	25 50		1,945 91
Assistant fish and game wardens—seasonal	32,670 06				32,670 06
Total Fish Conservation	$176,331 70	$71,061 61	$25,953 87	$7,696 14	$281,043 32
Hydraulics:					
Chief and assistant	$7,677 96				$7,677 96
General office	1,920 00	$72 78	$5 86	$26 32	2,024 96
Automobiles		364 58	87 20	10 97	462 75
Traveling			2,287 32		2,287 32
Telephone and telegraph			1 20		1 20
Blue printing		1 65	72 45		74 10
Temporary help	84 64				84 64
Total hydraulics	$9,682 60	$439 01	$2,454 03	$37 29	$12,612 93
Game Conservation:					
Chief and assistants	$16,033 29				$16,033 29
General office	4,035 00	$99 72	$27 60	$36 77	4,199 09
Automobiles		2,053 20	714 80	2,623 14	5,391 14
Traveling			4,538 34		4,538 34
Telephone and telegraph			418 33		418 33
Freight, cartage and express			131 13		131 13
Heat, light, water and power			3,333 91		3,333 91
Maintenance of game farms	12,098 97	17,104 18	560 40	3,039 09	32,802 64
Statistics	758 87	1 22	1,101 20		1,861 29
Temporary help	8,486 46				8,486 46
Maintenance of game refuges	4,358 00	2,308 39	751 70	705 52	8,123 61
Total Game Conservation	$45,770 59	$21,566 71	$11,577 41	$6,404 52	$85,319 23
Licenses:					
General office	$14,850 00	$923 50	$215 60	$27 16	$16,016 26
Printing licenses and applications		3,466 93			3,466 93
Traveling			384 27		384 27
Postage			1,136 13		1,136 13
Freight, cartage and express			43 39		43 39
Premiums on bonds			1,253 67		1,253 67
Identification license buttons		9,657 21			9,657 21
License commissions			54,993 46		54,993 46
Total licenses	$14,850 00	$14,047 64	$58,026 52	$27 16	$86,951 32
Special Item:					
State Fair and other exhibits (payable from support, Chap. 341-35 or E. O. for support)	$40 00	$117 37	$1,200 00		$1,357 37
Total eighty-eighth fiscal year expense paid from support appropriations	$584,405 84	$168,399 77	$250,402 81	$67,928 20	$1,071,136 62
Prior year, eighty-seventh fiscal year for support					54 34
Total eighty-seventh and eighty-eighth fiscal years for support					$1,071,190 96
Special Items:					
Predatory Animal Control:					
Eighty-eighth fiscal year:					
Chief and assistant	$3,700 00				$3,700 00
General office	897 72			$25 00	922 72
Automobiles		$3,321 63	$964 67	650 87	4,937 17
Traveling			3,152 36		3,152 36
Predatory animal control	20,765 76	1,420 37	6,354 99	15 14	28,556 26
Predatory animal hunters and trappers, seasonal	6,000 00				6,000 00
Freight, cartage and express			4 65		4 65
Total eighty-eighth fiscal year	$31,363 48	$4,742 00	$10,476 67	$691 01	$47,273 16
Total expenditures, eighty-seventh and eighty-eighth fiscal years					$1,118,464 12

STATEMENT OF EXPENDITURES—Continued

For the Period July 1, 1936, to June 30, 1937, of the Eighty-eighth Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Expenditures for Additions and Betterments:					
Permanent Improvements:					
Purchase of game refuges and public shooting grounds, and C. I. E. Chapter 341-35	$16,094 67	$26,221 94	$8,729 14	$18,596 26	$69,642 01
Contribution to Employees' Retirement System, eighty-eighth fiscal year					17,035 24
Total current biennium					$1,205,141 37
Special Item:					
Construction of Russian River jetties, Chapter 989-33:					
Eighty-eighth fiscal year			$215 25		$215 25
California Code Commission, Chap. 645-33			1 50		1 50
Total operating expenditures, eighty-eighth fiscal year			$216 75		$216 75
Grand totals					$1,205,358 12

SEIZURES OF FISH AND GAME

April, May, June, 1937

Game:	
Deer	3
Deer hides	3
Deer meat, pounds	596
Dove	8
Ducks	17
Grouse	1
Pheasant	12
Quail	4
Rabbits	15
Wood duck	1
Fish:	
Abalone	286
Barracuda, pounds	625
Bass, black	138
Bass, striped	51
Bass, striped, pounds	50
Bass, white sea, pounds	30
Carp	20
Catfish	25
Clams	1,536
Cockles	1,227
Crabs	289
Crappie	39
Grunion, pounds	10
Lobsters	321
Lobster traps	12
Minnows	11
Perch	51
Salmon, pounds	31
Sunfish	192
Trout	310
Trout, pounds	6½
Yellowfin tuna, pounds	3,509
Fishing rod	1
Reel and line	1

FISH CASES

April, May, June, 1937

Offense	Number arrests	Fines imposed	Jail sentences (days)
Abalones; out of shell; overlimit; undersize; taken in less than 20 feet of water	92	$1,662 50	16½
Anchoring; closed district	2	150 00	
Barracuda; undersize	1		
Bass, black; closed season; overlimit; undersize; spearing	15	180 00	10
Bass, striped; overlimit; selling; undersize; failure to deliver to Fish and Game Commission	22	370 00	90
Bass, white sea; overlimit	1	150 00	
Clams; from refuge; overlimit; undersize	44	670 00	369½
Cockles; overlimit; undersize	3	15 00	
Commercial fishing; no license	15	182 50	
Crabs; holding in live box; undersize	51	915 00	70
Failure to record fish purchased	1	25 00	
False statement, license application	1	10 00	
Fishing; no license; transferring license; using another's license; failure to show license on demand; using, possession prohibited gear; closed season; closed district; through ice; too near dam, ladder, traps; taking brood fish from hatchery	217	2,675 50	179
Fishing tackle in refuge	1	25 00	
Frogs; undersize	1	10 00	
Grunion; closed season	1		
Lobster; closed season	2		
Minnows transported	1	50 00	
Night fishing	3	35 00	
Pollution	17	530 00	
Sunfish; closed season; overlimit	19	180 00	
Trout; closed season; closed stream; overlimit; selling	24	520 00	10
Using fresh spawn	3	150 00	
Using explosives to take fish	1	100 00	
Totals	538	$8,605 50	745

GAME CASES

April, May, June, 1937

Offense	Number arrests	Fines imposed	Jail sentences (days)
Beaver hide; possession	2	$10 00	
Deer; closed season; killing, possession fawn, doe; possession spotted fawn	42	1,345 00	554
Destroying bird nests	1	25 00	
Doves; closed season	7	165 00	
Ducks; closed season	13	367 50	
False statement, license application	3	30 00	
Firearms in refuge	4	30 00	
Grebe; possession	1	5 00	
Grouse; possession	1	50 00	
Hunting; in refuge; no license	26	196 00	105
Illegal shooting	4	85 00	
Interfering with officer discharging his duties	1		
Mudhen; closed season	1	10 00	
Night hunting	1	25 00	
Non-game birds; possession	4	15 00	6
Pheasant; closed season; overlimit	14	447 50	6
Quail; closed season	5	160 00	
Rabbits; closed season	3	35 00	
Shorebird; possession	1		
Spotlight hunting	3		125
Trapping, no license	34	217 50	
Tree squirrel; possession	2	20 00	
Totals	173	$3,238 50	796

ARRESTS AND CONVICTIONS FOR VIOLATION OF FISH AND GAME CODE

July, 1935—June, 1937

Offense	Number arrests	Fines imposed	Jail sentences (days)
Fish cases, 1935-1936	1,316	$23,031 00	1,947½
Game cases, 1935-1936	1,070	25,211 49	6,841
Totals, 1935-1936	2,386	$48,242 49	8,788½
Fish cases, 1936-1937	1,618	$31,094 50	2,223½
Game cases, 1936-1937	1,480	40,122 06	5,933½
Totals, 1936-1937	3,098	$71,216 56	8,157
Recapitulation—			
1935-1936	2,386	$48,242 49	8,788½
1936-1937	3,098	71,216 56	8,157
Totals	5,484	$119,459 05	16,945½

TOTAL ARRESTS FOR A PERIOD OF THIRTY-FIVE YEARS

1902-1904	550
1904-1906	774
1906-1908	1,192
1908-1910	1,771
1910-1912	2,063
1912-1914	1,993
1914-1916	2,087
1916-1918	1,797
1918-1920	1,891
1920-1922	2,258
1922-1924	2,715
1924-1926	3,207
1926-1928	4,390
1928-1930	5,388
1930-1932	5,237
1932-1934	3,795
1934-1936	4,535
1936-1937	3,098

SEIZURES OF FISH AND GAME

Fish	July 1, 1935, to June 30, 1936	July 1, 1936, to June 30, 1937	Total
Abalone	1,246	1,037	2,283
Abalone, pounds	50	2,856	2,906
Abalone slices	1		1
Barracuda	3	125	128
Barracuda, pounds	5,267½	825	6,092½
Bass—			
Black	145	255	400
Black, pounds	5½		5½
Rock	1	4	5
Striped	601	438	1,039
Striped, pounds	557	250	807
White sea, pounds	1,150	69	1,219
White sea, barrels		60	60
Blue cod, pounds		4	4
Carp	20	20	40
Catfish		46	46
Catfish, pounds	1,275	70	1,345
Clams	6,820	5,860	12,680
Cockles	2,100	1,227	3,327
Cockles, pounds		225	225
Crabs	70	536	606
Crabs (cooked)	240		240
Crappie, perch, sunfish	961	433	1,394
Croaker, yellowfin	40	1	41
Grunion, pounds		10	10
Halibut, pounds	400		400
Live car	2	1	3
Lobsters	1,107	1,012	2,119
Lobsters, pounds	75	330	405
Lobster receivers	2	3	5
Lobster traps	197	12	209
Minnows		11	11
Mullet, pounds	157		157
Mussels, pounds	100		100
Salmon	31	76	107
Salmon, pounds	1,775	381	2,156
Shad, pounds	30		30
Skeins of fresh trout roe	2		2
Skipjack, pounds		52,157	52,157
Spears	2		2
Sturgeon, pounds		62	62
Trammel, net		1,500 ft.	1,500 ft.
Traps		11	11
Trout, steelhead	1,116	1,615	2,731
Trout, pounds	311½	156½	468
Tuna, pounds	7,636	6,421	14,057
Yellowfin, pounds		85,025	85,025
Yellowtail		1	1

SEIZURES OF FISH AND GAME—Continued

Game	July 1, 1935, to June 30, 1936	July 1, 1936, to June 30, 1937	Total
Bear		1	1
Deer	57	65	122
Deer feet	6		6
Deer heads	1	2	3
Deer hides	22	36	58
Deer meat	4 quart jars		4 quart jars
Deer meat, pounds	5,370	3,207½	8,577½
Doves	1,058	750	1,808
Ducks, geese, mudhens	584	2,638	3,222
Eagle		1	1
Egret	26		26
Godwit, marbled	2		2
Grebe	1	2	3
Grouse		5	5
Larks, horned	3		3
Meadowlark	10	4	14
Nongame birds	54	143	197
Owl	1		1
Pheasants	58	154	212
Pigeons	1	1	2
Plover	8	52	60
Quail	242	709	951
Rabbits	90	94	184
Rail		1	1
Robins	16		16
Shorebirds	8		8
Sparrow	1		1
Squirrels	4	2	6
Swan	3	4	7
Snipe	33		33
Tree squirrel		1	1
Tree squirrel hides		3	3
Wood duck		1	1
Woodpecker		3	3

GAME CASES

Offense	July 1, 1935, to June 30, 1936			July 1, 1936, to June 30, 1937		
	Arrests	Fines	Jail, days	Arrests	Fines	Jail, days
Antelope; possession buck				3	$100 00	
Bear; closed season	1		75			
Beaver hide; possession				2	10 00	
Bird nets; possession				1	25 00	
Concealed weapon carried				1	25 00	
Deer; closed season, district: killing, possession does, fawns, spike bucks, spotted fawns; evidence of sex removed; failure to tag; tags altered, mutilated, not returned; dogs running deer; failure to retain hide and horns; failure to mark packages	354	$11,160 00	3,757½	403	12,839 50	3,761½
Doves; closed season; overlimit	57	1,295 00	110	71	2,870 00	
Ducks, geese, mudhens; closed season; overlimit; sale	58	2,790 00	300	144	7,695 00	1,385
Eagle; possession				1	100 00	
Elk; possession				3		
Firearms in refuge; illegal possession of	46	606 00	39½	65	825 00	89½
Game birds; closed season				6	85 00	
Grebe; possession				1	5 00	
Grouse; closed season				5	360 00	
Hunting; no license, illegal license; false statement; in refuge; closed district; borrowing, transferring license; alien using citizen's license; failure to show game on demand; failure to show license on demand	275	3,746 00	1,549½	295	4,253 50	237½
Illegal shooting	26	450 00		88	1,607 50	11
Night hunting	5	65 00		16	410 00	
Nongame birds; killing, possession	45	585 00	32½	56	1,047 50	16
Pheasant; closed season; snaring; possession untagged; overlimit; shipping in closed packages	48	1,120 00	260	104	3,517 50	71
Pigeon; closed season	6	70 00	12½	2	25 00	
Protected birds; possession, killing	2	105 00		17	255 00	120
Quail; closed season; using for bait; overlimit; failure to tag domesticated; trapping	47	1,637 50	76	58	1,408 56	95
Rabbits; closed season; netting of	28	390 00		35	741 00	2
Spotlighting	39	725 00	252	32	1,195 00	135
Trapping; no license	3	70 00		38	219 50	10
Tree squirrels; killing, possession				9	145 00	
Trespassing				13	132 50	
Miscellaneous game cases	27	296 99	376½	11	225 00	
Totals	1,067	$25,111 49	6,841	1,480	$40,122 06	5,933½

FISH CASES

Offense	July 1, 1935, to June 30, 1936			July 1, 1936, to June 30, 1937		
	Arrests	Fines	Jail, days	Arrests	Fines	Jail, days
Abalones; drying of; overlimit; undersize; taken below high water line; closed season; out of shell; taken in less than 20 feet of water	165	$3,290 00	50	224	$4,041 50	339
Anchoring, closed district				2	150 00	
Barracuda; closed season; selling undersize; overlimit	12	305 00		4	115 00	
Bass—						
Black; closed season; undersize; overlimit; spearing	13	307 50	160	36	528 00	32
Striped; illegal shipment of; offering for sale; undersize; overlimit; failure to deliver to Fish and Game Commission	97	2,079 00	402	79	1,745 00	205
White sea; undersize; overlimit	1	100 00		6	520 00	
Catfish; closed season; undersize sold; keeping undersize in live car; failing to keep dealer's record	2	10 00				
Clams; overlimit; undersize; taken in clam refuge; out of shell; failure to show on demand; closed season; instrument in preserve; offering for transportation, selling overlimit	199	3,070 00	702½	194	4,044 00	1,127
Cockles; overlimit; undersize	3	75 00		3	15 00	
Commercial fishing; no license; no reports; boat not registered	138	990 00	40	138	997 50	5
Crabs; female; undersize; shipping in from closed district; holding in live box; closed season	41	700 00	20	96	1,660 00	100
Crappie, perch, sunfish; overlimit; closed season	16	270 00		24	270 00	
Failure to record fish purchased				1	25 00	
Fish wastage	5	255 00		3	100 00	
Fishing; from dam; too near dam, fishway, ladder, traps; closed stream; no license; failure to provide passage over dam; closed district; using, possession prohibited gear; failure to show license on demand; transferring license; using another's license; false statement on license application; through ice; taking brood fish from hatchery; using explosives; using fresh spawn	405	7,787 00	438	605	10,225 50	355½
Fishing tackle in refuge				1	25 00	
Frogs; undersize				1	10 00	
Grunion; closed season				1		
Lobsters; closed season; undersize; taken in traps; oversize	15	265 00	12½	20	205 00	10
Minnows transported				1	50 00	
Mussels taken in refuge	2		20			
Night fishing	47	559 00	30½	36	575 00	
Operating smokehouse; no packer's license				1		
Pollution	14	550 00		46	2,210 00	
Salmon; illegal taking of; closed season; clubbing; failure to stamp cans; overlimit; undersize; gaffing; transporting; spearing	18	325 00		21	365 00	30
Sardines; illegal use of; exceeding permit tonnage allotment; reducing without permit	4	215 00		5	1,600 00	
Skipjack; selling undersize				3	50 00	
Steelhead; overlimit				2	25 00	
Sturgeon, possession of				1	20 00	
Trout; clubbing; dynamiting; overlimit; closed season; spearing; closed stream; selling	91	1,636 00	42	54	1,173 00	20
Tuna, yellowfin; selling undersize				10	350 00	
Yellowtail; closed season; selling local to cannery	2					
Miscellaneous fish cases	27	342 50	30			
Totals	1,317	$23,131 00	1,947½	1,618	$31,094 50	2,223½

FRESH FISH IMPORTATIONS BY POINT OF ORIGIN* FOR APRIL, MAY AND JUNE, 1937

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	Gulf of California	West Coast Lower California	International waters south U. S. boundary (definite origin unknown)	Mexican mainland, Central and South America	Japan	Total pounds
Barracuda		184,910	1,075			185,985
Cabrilla	1,307	190	23,926			25,423
Corbina, Mexican	20,175					20,175
Cultus, Pacific		58				58
Grouper	2,508	15,416	712			18,636
Halibut, California		47,467	398			47,865
Mackerel, Pacific		88,802	80			88,882
Mackerel, Spanish		120				120
Perch		340				340
Pompano, Mexican		162				162
Rock Bass		54,367	676			55,043
Rockfish		52,069				52,069
Sculpin		198				198
Sea-bass, Black	104	70,100	28,486			98,690
Sea-bass, Totuava	318,868					318,868
Sea-bass, White		31,185	53			31,238
Shark		1,757	308			2,065
Sheepshead		1,124	380			1,504
Smelt		35				35
Sole		27				27
Swordfish, Broadbill		2,352				2,352
Swordfish, Marlin			490			490
Tuna, Albacore					222,531	222,531
Tuna, Bluefin		589,179	238,220			827,399
Tuna, Bonito		219,728	3,335			223,063
Tuna, Oriental					57,106	57,106
Tuna, Skipjack	523,357	818,167	7,326,210	239,327	4,049,818	12,956,879
Tuna, Yellowfin	394,402	2,086,365	22,583,566	4,969,978		30,034,311
Yellowfish		884	1,459			2,343
Yellowtail	239	1,205,591	73,650			1,279,480
Total pounds	1,260,960	5,470,593	30,283,024	5,209,305	4,329,455	46,553,337

*These importations are included in tables of landings. They include fish caught by California boats in foreign waters as well as frozen fish imported for canning in California plants.

FRESH FISH IMPORTATIONS* FROM FOREIGN COUNTRIES FOR APRIL, MAY AND JUNE, 1937

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	Landed in Region 70, Los Angeles	Landed in Region 80, San Diego	Total pounds
Barracuda	----	185,985	185,985
Cabrilla	20,695	4,728	25,423
Corbina, Mexican	20,175	----	20,175
Cultus, Pacific	----	58	58
Grouper	2,618	16,018	18,636
Halibut, California	----	47,865	47,865
Mackerel, Pacific	----	88,882	88,882
Mackerel, Spanish	----	120	120
Perch	----	340	340
Pompano, Mexican	----	162	162
Rock Bass	400	54,643	55,043
Rockfish	----	52,069	52,069
Sculpin	----	198	198
Sea-bass, Black	25,939	72,751	98,690
Sea-bass, Totuava	310,183	8,685	318,868
Sea-bass, White	----	31,238	31,238
Shark	----	2,065	2,065
Sheepshead	380	1,124	1,504
Smelt	----	35	35
Sole	----	27	27
Swordfish, Broadbill	----	2,352	2,352
Swordfish, Marlin	490	----	490
Tuna, Albacore	222,531	----	222,531
Tuna, Bluefin	720,174	107,225	827,399
Tuna, Bonito	3,588	219,475	223,063
Tuna, Oriental	57,106	----	57,106
Tuna, Skipjack	9,587,624	3,369,255	12,956,879
Tuna, Yellowfin	12,357,126	17,677,185	30,034,311
Whitefish	1,459	884	2,343
Yellowtail	84,528	1,194,952	1,279,480
Total pounds	23,415,016	23,138,321	46,553,337

*These importations are included in tables of landings. They include fish caught by California boats in foreign waters as well as frozen fish imported for canning in California plants.

CALIFORNIA FRESH FISH LANDINGS* FOR APRIL, MAY AND JUNE, 1937

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	Region 10, Del Norte	Region 20, Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds
Anchovy				72,200	18,885		6,962		98,047
Barracuda						2,656	835,090	352,664	1,190,410
Cabezone				1,650	179	129			1,958
Cabrilla							20,695	4,728	25,423
Carp			6,035						6,035
Catfish			48,015						48,015
Corbina, Mexican							20,175		20,175
Cultus, Pacific	1,578	16,893		117,452	8,249	10		86	144,268
Eel				12					12
Flounder, Starry		301		117,116	4,924				122,341
Flying Fish							13,163		13,163
Grouper							2,618	16,018	18,636
Hake				5,340					5,340
Halibut, California				1,424	2,392	62,630	140,403	96,283	303,132
Halibut, Northern	887	121,181		44,707					166,775
Hardhead			7,100						7,100
Herring, Pacific				862	3,425	6			4,293
Kingfish				3,482	29,768	10	114,809	148	148,217
Mackerel, Horse					21,986		1,334,724	79,626	1,436,336
Mackerel, Pacific					67,546	1,986	4,750,769	2,175,557	6,995,858
Mackerel, Spanish								120	120
Mullet							2,298	4,787	7,085
Perch	552	8,837		32,762	23,928	1,714	12,641	540	80,974
Pike			152						152
Pompano, California					86		752	40	878
Pompano, Mexican								162	162
Rock Bass						4,108	40,190	65,565	109,863
Rockfish	2,712	38,599		285,538	329,966	100,658	41,965	98,502	897,940
Sablefish	105	242,068		20,289	3,084		25,303		290,849
Salmon	222,974	570,091	131,000	569,496	765,890	922			2,260,373
Sand Dab				118,729	4,387	100	1,680		124,896
Sardine				406,350	753,148	583	8,490,362	54,600	9,705,043
Sculpin						84	31,618	680	32,382
Sea-bass, Black					29	2,798	27,969	73,108	103,904
Sea-bass, Short-fin								932	932
Sea-bass, Totuava							310,183	8,685	318,868
Sea-bass, White					3,016	4,452	11,745	71,390	90,603
Sea-trout, California				20					20
Shad			639,803	275	19				640,097

Shark		249		12,335	1,376	57,000	73,697	19,236	163,893
Sheepshead						1,022	9,648	1,124	11,794
Skate				58,445	3,733	13,582	2,957	600	79,317
Smelt		1,351		95,505	22,717	16,855	57,692	711	194,831
Sole				1,732,946	48,157	136,452	1,143	27	1,918,725
Split-tail			1,438						1,438
Sucker			177						177
Swordfish, Broadbill						3,812	23,469	20,589	47,870
Swordfish, Marlin							490		490
Tomcod				208					208
Tuna, Albacore							636,223	252,620	888,843
Tuna, Bluefin							7,548,350	285,705	7,834,055
Tuna, Bonito							2,057,722	593,606	2,651,328
Tuna, Oriental							57,106		57,106
Tuna, Skipjack							9,587,624	3,369,255	12,956,879
Tuna, Yellowfin							12,363,259	17,677,185	30,040,444
Turbot				19,176	2,653		4		21,833
Whitebait	21,049	24,371		4,928	1,250				51,598
Whitefish						446	2,509	884	3,839
Yellowtail							171,387	1,230,754	1,402,141
Miscellaneous Fish		348	11	30,037		408	197		31,001
Crustacean:									
Crab	7,952	49,284		160,543	228				218,007
Crab, Rock						5	235		240
Prawn					416				416
Shrimp				308,160					308,160
Mollusk:									
Abalone					512,375	432,717	46		945,138
Clam, Cockle				231			8,175		8,406
Clam, Gaper				860					860
Clam, Pismo					2,082	51,628			53,710
Clam, Soft-shell				23,516					23,516
Clam, Washington		2,665		999					3,664
Octopus		128		2,366	6,740	107			9,341
Oyster, Eastern				69,933					69,933
Oyster, Japanese			55,498	117,089					172,587
Oyster, Native				18,084					18,084
Squid					65,025	13	1,060		66,098
Total pounds	257,809	1,076,366	889,229	4,453,065	2,707,659	896,893	48,839,107	26,556,517	85,676,645

[1] Importations of fresh fish from foreign countries included. See foreign importation tables.

INDEX TO VOLUME 23

o

49659 12-37 2700
7--49659

BUREAU OF HYDRAULICS

JOHN SPENCER, Chief ---- San Francisco
Clarence Elliger, Assistant Hydraulic Engineer ---- San Francisco
Byron Wittorff, Assistant ---- San Francisco

BUREAU OF LICENSES

H. R. DUNBAR, Chief ---- Sacramento

BUREAU OF PATROL

E. L. MACAULAY, Chief of Patrol ---- San Francisco

CENTRAL DISTRICT (Headquarters, Sacramento)

S. H. Lyons, Inspector in Charge ---- Sacramento
L. E. Mercer, Warden, Flying Squad ---- Sacramento
G. T. Davis, Assistant Warden ---- Sacramento
Chas. Sibeck, Warden, Launch "Rainbow" ---- Sacramento

Northern Division

Jos. H. Sanders, Captain in Charge ---- Sacramento
A. H. Willard, Captain ---- Nevada City
————, Sergeant ---- Redding
A. A. Jordan, Warden, Modoc County ---- Alturas
Brice Hammack, Warden, Siskiyou County ---- Yreka
Fred R. Starr, Warden, Siskiyou County ---- Dorris
C. L. Gourley, Warden, Trinity County ---- Weaverville
Earl Caldwell, Warden, Shasta County ---- Burney
Chas. Love, Warden, Shasta County ---- Redding
C. O. Fisher, Warden, Lassen County ---- Susanville
W. C. Blewett, Warden, Plumas County ---- Quincy
R. W. Anderson, Warden, Tehama County ---- Red Bluff
E. C. Vail, Warden, Glenn County ---- Willows
E. O. Wraith, Warden, Butte County ---- Chico
A. Granstrom, Warden, Sierra County ---- Downieville
Earl Hiscox, Warden, Nevada County ---- Nevada City
R. A. Tinnin, Warden, Yuba County ---- Browns Valley
L. W. Dinsdale, Warden, Sutter County ---- Yuba City
Taylor London, Warden, Colusa County ---- Colusa
R. L. Sinkey, Warden, Yolo County ---- Woodland
W. J. Black, Warden, Solano County ---- Suisun
H. S. Vary, Warden, Sacramento County ---- Sacramento
Nelson Poole, Warden, Placer County ---- Auburn
Albert Sears, Warden, El Dorado County ---- Placerville

Southern Division

S. R. Gilloon, Captain in Charge ---- Fresno
John O'Connell, Captain ---- Stockton
————, Sergeant ---- Bakersfield
Wm. Hoppe, Warden, San Joaquin County ---- Lodi
R. J. Little, Warden, Amador County ---- Jackson
J. W. Thornburg, Warden, Calaveras County ---- Angels Camp
F. F. Johnston, Warden, Tuolumne County ---- Sonora
Geo. Magladry, Warden, Stanislaus County ---- Modesto
M. S. Clark, Warden, Merced County ---- Merced
Ray Ellis, Warden, Kings County ---- Hanford
Clarence Brown, Warden, Mariposa County ---- Mariposa
H. E. Black, Warden, Madera County ---- Madera
Paul Kehrer, Warden, Fresno County ---- Fresno
F. A. Bullard, Warden, Fresno County ---- Reedley
R. J. Bullard, Warden, Tulare County ---- Porterville
W. I. Long, Warden, Tulare County ---- Visalia
C. S. Donham, Warden, Merced County ---- Gustine
Lester Arnold, Warden, Kern County ---- Bakersfield
Roswell Welch, Warden, Kern County ---- Kernville

COAST DISTRICT (Headquarters, San Francisco)

K. P. Allred, Inspector in Charge ---- San Francisco
Scott Feland, Warden, Flying Squad ---- San Francisco

Northern Division

W. J. Harp, Captain in Charge ---- Ukiah
J. D. Dondero, Captain ---- Eureka
Henry Lencioni, Captain ---- Santa Rosa
John Hurley, Warden, Humboldt County ---- Eureka
W. F. Kaliher, Warden, Humboldt County ---- Fortuna

CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

Volume 23 San Francisco, January, 1937 Number 1

38512

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND GAME
San Francisco, California

FRANK F. MERRIAM — GOVERNOR
GEORGE D. NORDENHOLT — DIRECTOR OF NATURAL RESOURCES

FISH AND GAME COMMISSION

DR. E. C. MOORE, President — Los Angeles
A. T. JERGINS, Commissioner — Bel-air
I. ZELLERBACH, Commissioner — San Francisco
HERBERT C. DAVIS, Executive Officer, Division of Fish and Game — San Francisco

BUREAU OF FISH CONSERVATION

A. C. TAFT, Chief — San Francisco
J. H. Vogt, Assistant Chief — San Francisco
A. E. Burghduff, Hatchery Inspector — San Francisco
L. Phillips, Hatchery Inspector — San Francisco
J. W. Cook, Construction Estimator — San Francisco
E. R. Varnum, Construction Estimator — San Francisco
E. V. Cassell, Superintendent of Mt. Shasta Hatchery — Mt. Shasta
Geo. McCloud, Superintendent of Mt. Whitney Hatchery — Independence
D. A. Clanton, Superintendent Forest Home Hatchery — Forest Home
J. C. Lewis, Superintendent Tahoe Hatchery — Tahoe
Ed Clessen, Foreman Fort Seward Hatchery — Alderpoint
Earl Leitritz, Foreman Fall Creek Hatchery — Copco
Archie Thompson, Foreman Yosemite Hatchery — Yosemite
Wm. Berrian, Foreman Big Creek Hatchery — Davenport
Geo. E. West, Foreman Cold Creek Hatchery — Ukiah
J. L. Stinnett, Foreman Feather River Hatchery — Clio
R. A. McCloud, Foreman Kaweah Hatchery — Three Rivers
Donald Evins, Foreman Lake Almanor Hatchery — Westwood
H. E. Cole, Foreman Basin Creek Hatchery — Tuolumne
Peter Topp, Foreman Burney Creek Hatchery — Burney
C. L. Frame, Foreman Kings River Hatchery — Fresno
Allan Pollitt, Foreman Prairie Creek Hatchery — Orick
John Marshall, Foreman Brookdale Hatchery — Brookdale
Merrill Brown, Foreman Bass Hatchery and Fish Rescue — Elk Grove
G. C. Tobler, Fish Hatchery Man, Yuba River Hatchery — Camptonville
Preston Bills, Superintendent Distribution Car 01 — Mt. Shasta
Joseph Wales, Biological Surveyor — Mt. Shasta

BUREAU OF GAME CONSERVATION

J. S. HUNTER, Chief — San Francisco
August Bade, Superintendent of Game Farms — Yountville
D. D. McLean, Economic Biologist — San Francisco
Gordon H. True, Jr., Economic Biologist — San Francisco
A. D. McLellan, Game Refuge Supervisor — San Francisco
E. D. Platt, Assistant Superintendent of Game Farms — Chino

BUREAU OF COMMERCIAL FISHERIES

N. B. SCOFIELD, Chief — San Francisco
S. H. Dado, Assistant Chief — San Francisco
H. B. Nidever, Field Inspector — San Francisco
W. L. Scofield, Supervisor, California State Fisheries Laboratory — Terminal Island

BUREAU OF HYDRAULICS

JOHN SPENCER, Chief — San Francisco
Clarence Elliger, Assistant Hydraulic Engineer — San Francisco
Byron Wittorff, Assistant — San Francisco

BUREAU OF LICENSES

H. R. DUNBAR, Chief — Sacramento

BUREAU OF PATROL

E. L. MACAULAY, Chief of Patrol — San Francisco

CENTRAL DISTRICT (Headquarters, Sacramento)

S. H. Lyons, Inspector in Charge — Sacramento
Jos. H. Sanders, Captain Northern Division — Sacramento
S. R. Gilloon, Captain Southern Division — Fresno
John O'Connell, Captain — Modesto
A. H. Willard, Captain — Nevada City
__________, Sergeant — Redding

WARDENS (Northern Division)

Roy W. Anderson — Red Bluff
W. J. Black — Suisun
W. C. Blewett — Quincy
L. W. Dinsdale — Yuba City
C. O. Fisher — Susanville
C. L. Gourley — Weaverville
Alvin Granstrom — Downieville
Brice Hammack — Yreka
Earl Hiscox — Nevada City
J. E. Hughes — Sacramento
A. A. Jordan — Alturas
Taylor London — Colusa
Charles Love — Redding
Leslie Mercer — Sacramento
Nelson Poole — Auburn
Albert Sears — Placerville
Chas. Sibeck — Sacramento
R. L. Sinkey — Woodland
Fred R. Starr — Dorris
R. A. Tinnin — Challenge
E. C. Vail — Willows
H. S. Vary — Sacramento
Edwin O. Wraith — Chico

(Southern Division)

Lester Arnold — Bakersfield
H. E. Black — Madera
Clarence Brown — Mariposa
F. A. Bullard — Reedley
Ray J. Bullard — Porterville
M. S. Clark — Merced
Cliff Donham — Lemoore
Ray Ellis — Gustine
Wm. Hoppe — Lodi
F. F. Johnston — Sonora
Paul Kehrer — Fresno
R. J. Little — Jackson
Walter I. Long — Visalia
Geo. Magladry — Modesto
J. W. Thornburg — Angels Camp
Roswell Welch — Kernville

COAST DISTRICT (Headquarters, San Francisco)

K. P. Allred, Inspector in Charge — San Francisco
Wm. J. Harp, Captain Northern Division — Ukiah
Wm. Lippincott, Captain Southern Division — San Francisco
J. D. Dondero, Captain — Eureka
Henry Lencioni, Captain — Santa Rosa
Ralph Classic, Captain — Monterey
O. P. Brownlow, Captain — Alameda

WARDENS (Northern Division)

Earl Caldwell — Eureka
Ray Diamond — Willits
Len Garrett — Santa Rosa
J. H. Groves — Cloverdale
J. W. Harbuck — Napa
Ovid Holmes — Fort Bragg
John Hurley — Eureka
E. J. Johnson — Lakeport
Wm. F. Kaliher — Fortuna
Bert Laws — San Anselmo
Earl Macklin — Ukiah
Leo Mitchell — Point Arena
Tate Miller — Eureka
Victor Von Arx — Santa Rosa
R. J. Yates — San Rafael

(Southern Division)

C. M. Bouton — San Francisco
C. L. Bundock — Oakland
Ed Clements — Martinez
T. K. Duncan — Concord
Chas. England — San Rafael
Scott Feland — San Francisco
E. R. Greenleaf — Monterey
Fred W. Hecker — San Luis Obispo
C. E. Holladay — San Jose
Mansfield Joy — San Francisco
McPherson Lough — Palo Alto
F. J. McDermott — Santa Cruz
C. R. Peek — San Mateo
Orben Philbrick — Pacific Grove
Fred H. Post — Salinas
Lee C. Shea — San Francisco
Geo. Smalley — Richmond
Paul L. Turner — Paso Robles
J. P. Vissiere — San Juan Bautista
L. J. Weseth — Monterey

SOUTHERN DISTRICT (Headquarters, Los Angeles)

	Los Angeles
C. S. Bauder, Inspector in Charge	Los Angeles
LaRue Chappell, Captain Wetern Division	San Bernardino
E. H. Ober, Captain Eastern Division	Escondido
L. T. Ward, Captain	Terminal Island
C. H. Groat, Captain	Santa Barbara
________ Sergeant	Indio
________ Sergeant	Bishop
________ Sergeant	

WARDENS (Western Division)

Fred Albrecht	Los Angeles
A. R. Ainsworth	Santa Maria
R. E. Bedwell	Santa Barbara
E. A. Chan	Terminal Island
A. F. Crocker	Los Angeles
Walter Emerick	Van Nuys
Walter Engelke	Terminal Island
E. R. Hyde	Balboa
N. C. Kunkel	Terminal Island
E. H. Glidden	San Diego
W. L. Hare	Wilmington
H. C. Jackson	Santa Ana
Carmi Savage	Los Angeles
T. W. Schilling	San Diego
C. L. Towers	Los Angeles
T. J. Smith	Ventura
L. G. Van Vorhis	Terminal Island

(Eastern Division)

J. H. Gyger	Perris
Geo. Johnson	El Centro
Theo Jolley	Maywood
W. C. Malone	San Bernardino
R. C. O'Connor	Banning
W. S. Talbott	Pine Knot
C. J. Walters	Independence
E. L. Walker	Bishop

MARINE PATROL

Motor Vessel "Bluefin," Terminal Island
Motor Vessel "Albacore," Monterey
Cruiser "Quinnat III," San Francisco
Cruiser "Broadbill," Terminal Island
Cruiser "Yellowtail," Newport Beach
Launch "Rainbow," Sacramento
Launch "Hunter," Martinez
Launch "Shrapnel," Lakeport
Launch "Silverside," Eureka

CALIFORNIA STATE PRINTING OFFICE
GEORGE H. MOORE, STATE PRINTER
SACRAMENTO, 1937

CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

Volume 23 San Francisco, April, 1937 Number 2

43375

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND GAME
San Francisco, California

FRANK F. MERRIAM——GOVERNOR
GEORGE D. NORDENHOLT——DIRECTOR OF NATURAL RESOURCES

FISH AND GAME COMMISSION

DR. E. C. MOORE, President——Los Angeles
A. T. JERGINS, Commissioner——Bel-air
I. ZELLERBACH, Commissioner——San Francisco
HERBERT C. DAVIS, Executive Officer, Division of Fish and Game——San Francisco

BUREAU OF FISH CONSERVATION

A. C. TAFT, Chief——San Francisco
J. H. Vogt, Assistant Chief——San Francisco
A. E. Burghduff, Hatchery Inspector——San Francisco
L. Phillips, Hatchery Inspector——San Francisco
J. W. Cook, Construction Estimator——San Francisco
E. R. Varnum, Construction Estimator——San Francisco
E. V. Cassell, Superintendent of Mt. Shasta Hatchery——Mt. Shasta
Geo. McCloud, Superintendent of Mt. Whitney Hatchery——Independence
D. A. Clanton, Superintendent Forest Home Hatchery——Forest Home
J. C. Lewis, Superintendent Tahoe Hatchery——Tahoe
Ed Clessen, Foreman Fort Seward Hatchery——Alderpoint
Earl Leitritz, Foreman Fall Creek Hatchery——Copco
Archie Thompson, Foreman Yosemite Hatchery——Yosemite
Wm. Berrian, Foreman Big Creek Hatchery——Davenport
Geo. E. West, Foreman Cold Creek Hatchery——Ukiah
J. L. Stinnett, Foreman Feather River Hatchery——Clio
R. A. McCloud, Foreman Kaweah Hatchery——Three Rivers
Donald Evins, Foreman Lake Almanor Hatchery——Westwood
H. E. Cole, Foreman Basin Creek Hatchery——Tuolumne
Peter Topp, Foreman Burney Creek Hatchery——Burney
C. L. Frame, Foreman Kings River Hatchery——Fresno
Allan Pollitt, Foreman Prairie Creek Hatchery——Orick
John Marshall, Foreman Brookdale Hatchery——Brookdale
Merrill Brown, Foreman Central Valleys Hatchery and Fish Rescue——Elk Grove
G. C. Tabler, Fish Hatchery Man, Yuba River Hatchery——Comptonville
Clarence Chansler, Fish Hatchery Man, Madera Hatchery——The Falls
Preston Bills, Superintendent Distribution Car 01——Mt. Shasta
Joseph Wales, Biological Surveyor——Mt. Shasta

BUREAU OF GAME CONSERVATION

J. S. HUNTER, Chief——San Francisco
August Bade, Superintendent of Game Farms——Yountville
D. D. McLean, Economic Biologist——San Francisco
Gordon H. True, Jr., Economic Biologist——San Francisco
A. D. McLellan, Game Refuge Supervisor——San Francisco
E. D. Platt, Assistant Superintendent of Game Farms——Chino

BUREAU OF COMMERCIAL FISHERIES

N. B. SCOFIELD, Chief——San Francisco
S. H. Dado, Assistant Chief——San Francisco
H. B. Nidever, Field Inspector——San Francisco
W. L. Scofield, Supervisor, California State Fisheries Laboratory——Terminal Island

BUREAU OF HYDRAULICS

JOHN SPENCER, Chief——San Francisco
Clarence Elliger, Assistant Hydraulic Engineer——San Francisco
Byron Wittorff, Assistant——San Francisco

BUREAU OF LICENSES

H. R. DUNBAR, Chief——Sacramento

Ovid Holmes, Warden, Mendocino County — Fort Bragg
Earl Macklin, Warden, Mendocino County — Ukiah
Leo Mitchell, Warden, Mendocino County — Point Arena
E. J. Johnson, Warden, Lake County — Lakeport
J. H. Groves, Warden, Sonoma County — Cloverdale
Victor Von Arx, Warden, Sonoma County — Santa Rosa
J. W. Harbuck, Warden, Napa County — Napa
R. J. Yates, Warden, Marin County — San Rafael
Bert Laws, Warden, Marin County — San Anselmo

Southern Division

Wm. Lippincott, Captain in Charge — San Francisco
O. P. Brownlow, Captain — Alameda
————, Sergeant — Salinas
Ed Clements, Warden, Contra Costa County — Martinez
T. K. Duncan, Warden, Contra Costa County — Concord
C. L. Bundock, Warden, Alameda County — Oakland
C. E. Holladay, Warden, Santa Clara County — San Jose
McPherson Lough, Warden, Santa Clara County — Palo Alto
Lee C. Shea, Warden, San Francisco County — San Francisco
C. R. Peek, Warden, San Mateo County — San Mateo
F. J. McDermott, Warden, Santa Cruz County — Santa Cruz
J. P. Vissiere, Warden, San Benito County — San Juan Bautista
F. H. Post, Warden, Monterey County — Salinas
Orben Philbrick, Warden, Monterey County — Pacific Grove
F. W. Hecker, Warden, San Luis Obispo County — San Luis Obispo
L. R. Garrett, Warden, San Luis Obispo County — Paso Robles

Marine Fisheries Detail (Coast District)

Ralph Classic, Captain — Monterey
L. J. Weseth, Master, M. V. "Albacore" — Monterey
C. M. Bouton, Warden, Cruiser "Quinnat III" — San Francisco
Otis Wright, Assistant Warden, Cruiser "Quinnat III" — San Francisco
Tate Miller, Warden — Eureka
G. R. Smalley, Warden — Richmond

SOUTHERN DISTRICT (Headquarters, Los Angeles)

C. S. Bauder, Inspector in Charge — Los Angeles
Theo. Jolley, Warden, Flying Squad — Los Angeles
Fred Albrecht, Assistant Warden, Flying Squad — Los Angeles

Western Division

L. F. Chappell, Captain in Charge — Los Angeles
L. T. Ward, Captain — Escondido
————, Sergeant — Santa Barbara
A. R. Ainsworth, Warden, Santa Barbara County — Santa Maria
R. E. Bedwell, Warden, Santa Barbara County — Santa Barbara
G. N. Johnson, Warden, Ventura County — Ventura
A. F. Crocker, Warden, Los Angeles County — Los Angeles
Walter Emerick, Warden, Los Angeles County — Van Nuys
W. L. Hare, Warden, Los Angeles County — Wilmington
H. C. Jackson, Warden, Orange County — Santa Ana
E. H. Glidden, Warden, San Diego County — San Diego

Eastern Division

E. H. Ober, Captain in Charge — San Bernardino
————, Sergeant — Bishop
————, Sergeant — Banning
E. L. Walker, Assistant Warden, Mono County — Bishop
C. J. Walters, Warden, Inyo County — Independence
W. C. Malone, Warden, San Bernardino County — San Bernardino
W. S. Talbott, Warden, San Bernardino County — Pine Knot
J. H. Gyger, Warden, Riverside County — Perris
R. C. O'Conner, Warden, Riverside County — Banning

Marine Fisheries Detail (Southern District)

C. H. Groat, Captain in Charge — Terminal Island
Walter Engelke, Master, M. V. "Bluefin" — Terminal Island
E. R. Hyde, Warden, Cruiser "Yellowtail" — Balboa
Robt. Cowell, Assistant Warden, Cruiser "Yellowtail" — Balboa
Carmi Savage, Warden, Cruiser "Bonito" — Santa Barbara
Karl Lund, Assistant Warden, Cruiser "Bonito" — Santa Barbara
N. C. Kunkel, Warden — Terminal Island
E. A. Chan, Warden — Terminal Island
L. G. Van Vorhis, Warden — Terminal Island
T. W. Schilling, Warden — San Diego
Erol Greenleaf, Warden — Terminal Island

T. J. Smith, Warden — Terminal Island
R. E. Tutt, Assistant Warden, Cruiser "Broadbill" — Santa Monica
K. H. Shebley, Assistant Warden, Cruiser "Broadbill" — Santa Monica
W. Scrimsher, Assistant Warden, Cruiser "Marlin" — San Diego
D. E. Glass, Assistant Warden, Cruiser "Marlin" — San Diego

POLLUTION DETAIL

Paul Shaw, Chemist in Charge — San Francisco
C. L. Towers, Warden — Los Angeles
Wm. La Marr, Assistant Warden — Los Angeles
E. A. Johnson, Assistant Warden — San Francisco
Don Davison, Assistant Warden — Klamath River

CALIFORNIA JUNIOR GAME PATROL

M. F. Joy, Warden, Superintendent Junior Game Patrol — San Francisco

MARINE PATROL

Motor Vessel "Bluefin," Terminal Island
Motor Vessel "Albacore," Monterey
Cruiser "Yellowtail," Newport Harbor
Cruiser "Broadbill," Santa Monica
Cruiser "Quinnat III," San Francisco
Cruiser "Bonito," Santa Barbara
Cruiser "Marlin," San Diego
Launch "Rainbow," Sacramento
Launch "Shrapnel," Lakeport
Launch "Silverside," Eureka

CALIFORNIA STATE PRINTING OFFICE
GEORGE H. MOORE, STATE PRINTER
SACRAMENTO, 1937

CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

Volume 23 San Francisco, July, 1937 Number 3

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND GAME
San Francisco, California

FRANK F. MERRIAM ---------- GOVERNOR
GEORGE D. NORDENHOLT ---------- DIRECTOR OF NATURAL RESOURCES

FISH AND GAME COMMISSION

DR. E. C. MOORE, President ---------- Los Angeles
A. T. JERGINS, Commissioner ---------- Bel Air
I. ZELLERBACH, Commissioner ---------- San Francisco
HERBERT C. DAVIS, Executive Officer, Division of Fish and Game ---------- San Francisco

BUREAU OF FISH CONSERVATION

A. C. TAFT, Chief ---------- San Francisco
J. H. Vogt, Assistant Chief ---------- San Francisco
A. E. Burghduff, Hatchery Inspector ---------- San Francisco
L. Phillips, Hatchery Inspector ---------- San Francisco
E. R. Varnum, Construction Estimator ---------- San Francisco
E. V. Cassell, Superintendent of Mt. Shasta Hatchery ---------- Mt. Shasta
Geo. McCloud, Superintendent of Mt. Whitney Hatchery ---------- Independence
D. A. Clanton, Superintendent Forest Home Hatchery ---------- Forest Home
J. C. Lewis, Superintendent Tahoe Hatchery ---------- Tahoe
Ed Clessen, Foreman Fort Seward Hatchery ---------- Alderpoint
Earl Leitritz, Foreman Fall Creek Hatchery ---------- Copco
Archie Thompson, Foreman Yosemite Hatchery ---------- Yosemite
Wm. Berrian, Foreman Big Creek Hatchery ---------- Davenport
Geo. E. West, Foreman Cold Creek Hatchery ---------- Ukiah
J. L. Stinnett, Foreman Feather River Hatchery ---------- Clio
R. A. McCloud, Foreman Kaweah Hatchery ---------- Three Rivers
Donald Evins, Foreman Lake Almanor Hatchery ---------- Westwood
H. E. Cole, Foreman Basin Creek Hatchery ---------- Tuolumne
Peter Topp, Foreman Burney Creek Hatchery ---------- Burney
C. L. Frame, Foreman Kings River Hatchery ---------- Fresno
Allan Pollitt, Foreman Prairie Creek Hatchery ---------- Orick
John Marshall, Foreman Brookdale Hatchery ---------- Brookdale
Merrill Brown, Foreman Central Valleys Hatchery and Fish Rescue ---------- Elk Grove
G. C. Tabler, Fish Hatchery Man, Yuba River Hatchery ---------- Camptonville
Clarence Chansler, Fish Hatchery Man, Madera Hatchery ---------- The Falls
H. H. Hewitt, Fish Hatchery Man, Alpine Hatchery ---------- Markleeville
Preston Bills, Superintendent Distribution Car 01 ---------- Mt. Shasta
Joseph Wales, Biological Surveyor ---------- Mt. Shasta

BUREAU OF GAME CONSERVATION

J. S. HUNTER, Chief ---------- San Francisco
August Bade, Superintendent of Game Farms ---------- Yountville
D. D. McLean, Economic Biologist ---------- San Francisco
Gordon H. True, Jr., Economic Biologist ---------- San Francisco
A. D. McLellan, Game Refuge Supervisor ---------- San Francisco
E. D. Platt, Assistant Superintendent of Game Farms ---------- Chino

BUREAU OF MARINE FISHERIES

N. B. SCOFIELD, Chief ---------- San Francisco
S. H. Dado, Assistant Chief ---------- San Francisco
H. B. Nidever, Field Inspector ---------- San Francisco
W. L. Scofield, Supervisor, California State Fisheries Laboratory ---------- Terminal Island

BUREAU OF HYDRAULICS

JOHN SPENCER, Chief ---------- San Francisco
Clarence Elliger, Assistant Hydraulic Engineer ---------- San Francisco
Byron Wittorff, Assistant ---------- San Francisco

BUREAU OF LICENSES

H. R. DUNBAR, Chief ---------- Sacramento

Ovid Holmes, Warden, Mendocino County—Fort Bragg
Earl Macklin, Warden, Mendocino County—Ukiah
Leo Mitchell, Warden, Mendocino County—Point Arena
E. J. Johnson, Warden, Lake County—Lakeport
J. H. Groves, Warden, Sonoma County—Cloverdale
Victor Von Arx, Warden, Sonoma County—Santa Rosa
J. W. Harbuck, Warden, Napa County—Napa
R. J. Yates, Warden, Marin County—San Rafael
Bert Laws, Warden, Marin County—San Anselmo

Southern Division

Wm. Lippincott, Captain in Charge—San Francisco
O. P. Brownlow, Captain—Alameda
————, Sergeant—Salinas
Ed Clements, Warden, Contra Costa County—Martinez
T. K. Duncan, Warden, Contra Costa County—Concord
C. L. Bundock, Warden, Alameda County—Oakland
C. E. Holladay, Warden, Santa Clara County—San Jose
McPherson Lough, Warden, Santa Clara County—Palo Alto
Lee C. Shea, Warden, San Francisco County—San Francisco
C. R. Peek, Warden, San Mateo County—San Mateo
F. J. McDermott, Warden, Santa Cruz County—Santa Cruz
J. P. Vissiere, Warden, San Benito County—San Juan Bautista
F. H. Post, Warden, Monterey County—Salinas
Orben Philbrick, Warden, Monterey County—Pacific Grove
F. W. Hecker, Warden, San Luis Obispo County—San Luis Obispo
L. R. Garrett, Warden, San Luis Obispo County—Paso Robles

Marine Fisheries Detail (Coast District)

Ralph Classic, Captain—Monterey
L. J. Weseth, Master, M. V. "Albacore"—Monterey
Kenneth Hooker, Warden, Cruiser "Quinnat III"—San Francisco
Sheldon Brennaaun, Assistant Warden, Cruiser "Quinnat III"—San Francisco
Tate Miller, Warden—Eureka
G. R. Smalley, Warden—Richmond

SOUTHERN DISTRICT (Headquarters, Los Angeles)

C. S. Bauder, Inspector in Charge—Los Angeles
Theo. Jolley, Warden, Flying Squad—Los Angeles
Fred Albrecht, Assistant Warden, Flying Squad—Los Angeles

Western Division

L. F. Chappell, Captain in Charge—Los Angeles
L. T. Ward, Captain—Escondido
————, Sergeant—Santa Barbara
A. R. Ainsworth, Warden, Santa Barbara County—Santa Maria
R. E. Bedwell, Warden, Santa Barbara County—Santa Barbara
G. N. Johnson, Warden, Ventura County—Ventura
A. F. Crocker, Warden, Los Angeles County—Los Angeles
Walter Emerick, Warden, Los Angeles County—Van Nuys
W. L. Hare, Warden, Los Angeles County—Wilmington
H. C. Jackson, Warden, Orange County—Santa Ana
E. H. Glidden, Warden, San Diego County—San Diego

Eastern Division

E. H. Ober, Captain in Charge—San Bernardino
————, Sergeant—Bishop
————, Sergeant—Banning
E. L. Walker, Assistant Warden, Mono County—Bishop
C. J. Walters, Warden, Inyo County—Independence
W. C. Malone, Warden, San Bernardino County—San Bernardino
W. S. Talbott, Warden, San Bernardino County—Pine Knot
J. H. Gyger, Warden, Riverside County—Perris
R. C. O'Conner, Warden, Riverside County—Banning

Marine Fisheries Detail (Southern District)

C. H. Groat, Captain in Charge—Terminal Island
Walter Engelke, Master, M. V. "Bluefin"—Terminal Island
E. R. Hyde, Warden, Cruiser "Yellowtail"—Balboa
Robt. Cowell, Assistant Warden, Cruiser "Yellowtail"—Balboa
Carmi Savage, Warden, Cruiser "Bonito"—Santa Barbara
Karl Lund, Assistant Warden, Cruiser "Bonito"—Santa Barbara
N. C. Kunkel, Warden—Terminal Island
E. A. Chan, Warden—Terminal Island
L. G. Van Vorhis, Warden—Terminal Island
T. W. Schilling, Warden—San Diego
Erol Greenleaf, Warden—Terminal Island

T. J. Smith, Warden---Terminal Island
R. E. Tutt, Assistant Warden, Cruiser "Broadbill"-------------------Santa Monica
K. H. Shebley, Assistant Warden, Cruiser "Broadbill"----------------Santa Monica
W. Scrimsher, Assistant Warden, Cruiser "Marlin"----------------------San Diego
D. E. Glass, Assistant Warden, Cruiser "Marlin"-----------------------San Diego

POLLUTION DETAIL

Paul Shaw, Chemist in Charge---------------------------------------San Francisco
C. L. Towers, Warden---Los Angeles
Wm. La Marr, Assistant Warden-------------------------------------Los Angeles
E. A. Johnson, Assistant Warden----------------------------------San Francisco
Don Davison, Assistant Warden------------------------------------Klamath River

CALIFORNIA JUNIOR GAME PATROL

M. F. Joy, Warden, Superintendent Junior Game Patrol-------------San Francisco

MARINE PATROL

Motor Vessel "Bluefin," Terminal Island
Motor Vessel "Albacore," Monterey
Cruiser "Yellowtail," Newport Harbor
Cruiser "Broadbill," Santa Monica
Cruiser "Quinnat III," San Francisco
Cruiser "Bonito," Santa Barbara
Cruiser "Marlin," San Diego
Launch "Rainbow," Sacramento
Launch "Shrapnel," Lakeport
Launch "Silverside," Eureka
Launch "Sturgeon," Martinez

CALIFORNIA STATE PRINTING OFFICE
GEORGE H. MOORE, STATE PRINTER
SACRAMENTO, 1937

CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

Volume 23 San Francisco, October, 1937 Number 4

49659

STATE OF CALIFORNIA

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF FISH AND GAME

San Francisco, California

FRANK F. MERRIAM — GOVERNOR
GEORGE D. NORDENHOLT — DIRECTOR OF NATURAL RESOURCES

FISH AND GAME COMMISSION

DR. E. C. MOORE, President — Los Angeles
A. T. JERGINS, Commissioner — Bel Air
I. ZELLERBACH, Commissioner — San Francisco
HERBERT C. DAVIS, Executive Officer, Division of Fish and Game — San Francisco

BUREAU OF FISH CONSERVATION

A. C. TAFT, Chief — San Francisco
J. H. Vogt, Assistant Chief — San Francisco
A. E. Burghduff, Hatchery Inspector — San Francisco
L. Phillips, Hatchery Inspector — San Francisco
E. R. Varnum, Construction Estimator — San Francisco
E. V. Cassell, Superintendent of Mt. Shasta Hatchery — Mt. Shasta
Geo. McCloud, Superintendent of Mt. Whitney Hatchery — Independence
D. A. Clanton, Superintendent Forest Home Hatchery — Forest Home
J. C. Lewis, Superintendent Tahoe Hatchery — Tahoe
Ed Clessen, Foreman Fort Seward Hatchery — Alderpoint
Earl Leitritz, Foreman Fall Creek Hatchery — Copco
Archie Thompson, Foreman Yosemite Hatchery — Yosemite
Wm. Berrian, Foreman Big Creek Hatchery — Davenport
Geo. E. West, Foreman Cold Creek Hatchery — Ukiah
J. L. Stinnett, Foreman Feather River Hatchery — Clio
R. A. McCloud, Foreman Kaweah Hatchery — Three Rivers
Donald Evins, Foreman Lake Almanor Hatchery — Westwood
H. E. Cole, Foreman Basin Creek Hatchery — Tuolumne
Peter Topp, Foreman Burney Creek Hatchery — Burney
C. L. Frame, Foreman Kings River Hatchery — Fresno
Allan Pollitt, Foreman Prairie Creek Hatchery — Orick
John Marshall, Foreman Brookdale Hatchery — Brookdale
Merrill Brown, Foreman Central Valleys Hatchery and Fish Rescue — Elk Grove
G. C. Tabler, Fish Hatchery Man, Yuba River Hatchery — Camptonville
Clarence Chansler, Fish Hatchery Man, Madera Hatchery — Bass Lake
H. H. Hewitt, Fish Hatchery Man, Alpine Hatchery — Markleeville
Preston Bills, Superintendent Distribution Car 01 — Mt. Shasta
Joseph Wales, Biological Surveyor — Mt. Shasta
Leo Shapovalov, Senior Researcher — Stanford University
Brian Curtis, Senior Researcher — Stanford University

BUREAU OF GAME CONSERVATION

J. S. HUNTER, Chief — San Francisco
Donald D. McLean, Economic Biologist — San Francisco
Gordon H. True, Jr., Economic Biologist — San Francisco
August Bade, Superintendent of Game Farms — Yountville
E. D. Platt, Superintendent Los Serranos Game Farm — Chino
A. D. McLellan, Game Refuge Supervisor — San Francisco
Roy M. Wattenbarger, Supervisor Los Banos Refuge — Los Banos
L. H. Cloyd, Supervisor Gray Lodge Refuge — Gridley
Russell M. Reedy, Supervisor Imperial Refuge — Calipatria
Joe Vlasnik, Jr., Supervisor Elk Refuge — Tupman
John R. Wallace, Supervisor Predatory Animal Control — San Francisco
Asa L. Brown, Supervising Trapper — Standish
John L. McDonald, Supervising Trapper — Weaverville
O. R. Shaw, Supervising Trapper — Springville
Jay C. Bruce, Lion Hunter — San Francisco
Chas. Ledshaw, Lion Hunter — San Francisco

BUREAU OF MARINE FISHERIES

N. B. SCOFIELD, Chief — San Francisco
S. H. Dado, Assistant Chief — San Francisco
H. B. Nidever, Field Inspector — San Francisco
Paul Bonnot, Senior Fisheries Researcher — Stanford University
California State Fisheries Laboratory
W. L. Scofield, Supervisor — Terminal Island
Frances N. Clark, Senior Fisheries Researcher — Terminal Island
G. H. Clark, Senior Fisheries Researcher — Stanford University
Harry C. Godsil, Senior Fisheries Researcher — San Diego
Donald H. Fry, Jr., Senior Fisheries Researcher — Terminal Island
Richard S. Croker, Senior Fisheries Researcher — Terminal Island
J. B. Phillips, Senior Fisheries Researcher — Pacific Grove
Geraldine Conner, Fisheries Statistician — Terminal Island
John F. Janssen, Jr., Junior Fisheries Researcher — Terminal Island
S. Ross Hatton, Junior Fisheries Researcher — Stanford University
Phil M. Roedel, Junior Fisheries Researcher — Terminal Island
J. Alfred Aplin, Junior Fisheries Researcher — Terminal Island
C. R. Clothier, Junior Fisheries Researcher — Terminal Island

Ovid Holmes, Warden, Mendocino County — Fort Bragg
Earl Macklin, Warden, Mendocino County — Ukiah
Leo Mitchell, Warden, Mendocino County — Point Arena
R. W. Remler, Assistant Warden, Mendocino County — Ukiah
E. J. Johnson, Warden, Lake County — Lakeport
J. H. Groves, Warden, Sonoma County — Cloverdale
Victor Von Arx, Warden, Sonoma County — Santa Rosa
J. W. Harbuck, Warden, Napa County — Napa
R. J. Yates, Warden, Marin County — San Rafael
Bert Laws, Warden, Marin County — San Anselmo

Southern Division

Wm. Lippincott, Captain in Charge — San Francisco
O. P. Brownlow, Captain — Alameda
————, Sergeant — Salinas
Ed Clements, Warden, Contra Costa County — Martinez
T. K. Duncan, Warden, Contra Costa County — Concord
C. L. Bundock, Warden, Alameda County — Oakland
C. E. Holladay, Warden, Santa Clara County — San Jose
Lee C. Shea, Warden, San Francisco County — San Francisco
C. R. Peek, Warden, San Mateo County — San Mateo
F. J. McDermott, Warden, Santa Cruz County — Santa Cruz
J. P. Vissiere, Warden, San Benito County — San Juan Bautista
F. H. Post, Warden, Monterey County — Salinas
Orben Philbrick, Warden, Monterey County — Pacific Grove
L. R. Garrett, Warden, Monterey County — Pacific Grove
D. J. Chipman, Assistant Warden, Monterey County — Pacific Grove
F. W. Hecker, Warden, San Luis Obispo County — San Luis Obispo

Marine Fisheries Detail (Coast District)

Ralph Classic, Captain — Monterey
L. J. Weseth, Master, M. V. "Albacore" — Monterey
Kenneth Hooker, Warden, Cruiser "Quinnat III" — San Francisco
W. H. Sholes, Assistant Warden, Cruiser "Quinnat III" — San Francisco
Tate Miller, Warden — Eureka
G. R. Smalley, Warden — Richmond

SOUTHERN DISTRICT (Headquarters, Los Angeles)

C. S. Bauder, Inspector in Charge — Los Angeles
E. H. Ober, Captain — Los Angeles
A. Crocker, Warden — Los Angeles
Theo. Jolley, Warden, Flying Squad — Los Angeles
Fred Albrecht, Assistant Warden, Flying Squad — Los Angeles
Ray Diamond, Warden, Flying Squad — San Bernardino
A. L. Stager, Assistant Warden, Flying Squad — San Bernardino

Western Division

L. F. Chappell, Captain in Charge — Los Angeles
L. T. Ward, Captain — Escondido
————, Sergeant — Santa Barbara
A. R. Ainsworth, Warden, Santa Barbara County — Santa Maria
R. E. Bedwell, Warden, Santa Barbara County — Santa Barbara
G. N. Johnson, Warden, Ventura County — Ventura
A. F. Crocker, Warden, Los Angeles County — Los Angeles
Walter Emerick, Warden, Imperial County — Brawley
W. L. Hare, Warden, Los Angeles County — San Fernando
H. C. Jackson, Warden, Orange County — Santa Ana
E. H. Glidden, Warden, San Diego County — San Diego

Eastern Division

————, Sergeant — Bishop
————, Sergeant — Banning
E. L. Walker, Assistant Warden, Mono County — Bishop
C. J. Walters, Warden, Inyo County — Independence
W. C. Malone, Warden, San Bernardino County — San Bernardino
W. S. Talbott, Warden, San Bernardino County — Pine Knot
J. H. Gyger, Warden, Riverside County — Perris
R. C. O'Conner, Warden, Riverside County — Banning

Marine Fisheries Detail (Southern District)

C. H. Groat, Captain in Charge---Terminal Island
Walter Engelke, Master, M. V. "Bluefin"---Terminal Island
E. R. Hyde, Warden, Cruiser "Yellowtail"---Balboa
Robt. Cowell, Assistant Warden, Cruiser "Yellowtail"---Balboa
Carmi Savage, Warden, Cruiser "Bonito"---Santa Barbara
Karl Lund, Assistant Warden, Cruiser "Bonito"---Santa Barbara
N. C. Kunkel, Warden---Terminal Island
E. A. Chan, Warden---Terminal Island
L. G. Van Vorhis, Warden---Terminal Island
Erol Greenleaf, Warden---Terminal Island
T. J. Smith, Warden---Terminal Island
———, Assistant Warden, Cruiser "Broadbill"---Santa Monica
K. H. Shebley, Assistant Warden, Cruiser "Broadbill"---Santa Monica
W. Scrimsher, Assistant Warden, Cruiser "Marlin"---San Diego
D. E. Glass, Assistant Warden, Cruiser "Marlin"---San Diego

POLLUTION DETAIL

Paul Shaw, Chemist in Charge---San Francisco
C. L. Towers, Warden---Los Angeles
Wm. La Marr, Assistant Warden---Oakland
E. A. Johnson, Assistant Warden---San Francisco
Don Davison, Assistant Warden---Weaverville
R. Schoen, Assistant Warden---Los Angeles

CALIFORNIA JUNIOR GAME PATROL

M. F. Joy, Warden, Superintendent Junior Game Patrol---San Francisco

MARINE PATROL

Motor Vessel "Bluefin," Terminal Island
Motor Vessel "Albacore," Monterey
Cruiser "Yellowtail," Newport Harbor
Cruiser "Broadbill," Santa Monica
Cruiser "Quinnat III," San Francisco
Cruiser "Bonito," Santa Barbara
Cruiser "Marlin," San Diego
Launch "Rainbow," Sacramento
Launch "Shrapnel," Lakeport
Launch "Silverside," Eureka
Launch "Sturgeon," Martinez

CALIFORNIA STATE PRINTING OFFICE
GEORGE H. MOORE, STATE PRINTER
SACRAMENTO, 1937